JOURNAL
OF
ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

VOL. 8 OCTOBER, 1915 No. 5

Report of Special Meeting of the American Association of Economic Entomologists, Berkeley, California, August 9 and 10, 1915.

A special meeting of the American Association of Economic Entomologists was held at the University of California, August 9 and 10, 1915. Joint sessions were also held with the Pacific Slope Association of Economic Entomologists.

The attendance at each session averaged 45. Among the members and visitors present were the following:

E. A. Back, Honolulu, H. T.; E. D. Ball, Logan, Utah; F. C. Bishopp, Dallas, Texas; Lawrence Bruner, Lincoln, Neb.; A. F. Burgess, Melrose Highlands, Mass.; R. E. Campbell, Hayward, Calif.; Mrs. R. E. Campbell, Hayward, Calif.; H. G. Champion, Oxford, England; Leroy Childs, Hood River, Oregon; T. D. A. Cockerell, Boulder, Calif.; G. A. Coleman, Berkeley, Calif.; R. A. Cooley, Bozeman, Mont.; W. M. Davidson, Walnut Creek, Calif.; E. M. Ehrhorn, Honolulu, H. T.; E. O. Essig, Berkeley, Calif.; S. W. Foster, San Francisco, Calif.; Geo. P. Gray, Berkeley, Calif.; Ralph Hopping, San Francisco, Calif.; L. O. Howard, Washington, D. C.; S. A. Johnson, Ft. Collins, Colo.; A. L. Melander, Pullman, Wash.; J. M. Miller, Ashland, Oregon; R. L. Nougaret, Walnut Creek, Calif.; C. E. Pemberton, Honolulu, H. T.; D. O. Robinson, Imperial, Calif.; E. E. Scholl, Austin, Texas; Mrs. E. E. Scholl, Austin, Texas; H. S. Smith, Sacramento, Calif.; A. T. Speare, Honolulu, H. T.; Mrs. A. T. Speare, Honolulu, H. T.; A. E. Stene, Kingston, R. I.; A. F. Swain, Berkeley, Calif.; O. H. Swezey, Honolulu, H. T.; Mrs. O. H. Swezey, Honolulu, H. T.; T. D. Urbahns, Pasadena, Calif.; E. P. Van Dyke, Berkeley, Calif.; F. A. Varrelman, Berkeley, Calif.; H. L. Viereck, Sacramento, Calif.; Alfred Warren, Honolulu, H. T.; G. P. Weldon, Sacramento, Calif.; H. F. Wilson, Corvallis, Oregon; and G. N. Wolcott, Rio Piedras, Porto Rico.

In the absence of President Herrick the meeting was called to order by Prof. R. A. Cooley, first vice-president of the Association.

A committee consisting of H. F. Wilson and the secretary were appointed to arrange the program and Dr. L. O. Howard was called to the chair.

The following address was presented by Vice-President Cooley:

COMMENTS ON ORGANIZATION IN AGRICULTURAL COLLEGE EXTENSION WORK IN ECONOMIC ENTOMOLOGY

By R. A. Cooley, *Professor of Zoölogy and Entomology, Montana Agricultural College, Bozeman, Montana*

Certain factors, recently new, tend greatly to stimulate interest in extension work in economic entomology. The same factors have given a new impetus as well to the extension efforts in other departments of agricultural knowledge but to those branches of the agricultural college often spoken of as the science departments, and including entomology, which are concerned in the more specialized branches of agricultural knowledge and require particularly the service of specialists, the new movement comes bringing particular interest, new responsibilities and, above all, a great opportunity. In the opinion of the writer, official economic entomologists, in particular, are called upon to make a special effort in order that a right beginning may be made and that the fullest measure of good may result eventually from the present rapidly changing conditions. I refer in particular to the Smith-Lever Act which became a law on May 8, 1914, and to certain items in the appropriations to the United States Department of Agriculture which authorizes extension work, but which are being expended largely in coöperation with, and under the direction of, the agricultural colleges in the several states.

When the Smith-Lever Act becomes fully effective in the fiscal year 1922–23, if the states all accept the federal allotments, there will be available in the United States from federal and state treasuries the sum of $9,160,000 to which may be added unknown but very material sums from the United States Department of Agriculture and from upward of 3,100 counties, all of which sums are to be expended under the direction of the agricultural colleges in extending "useful and practical information on subjects relating to agriculture and home economics." There is a very general sentiment that the counties should each appropriate a sum equal to that received from the state and federal governments. If this standard is reached the sum, aside from that received through the Department of Agriculture, will be again doubled. We may, therefore, roughly estimate that this work will be supported in about ten years by something like $20,000,000 annually.

The agricultural college has thus laid out before it a new condition full of great possibilities to which it must adjust itself during the next few years. Economic entomologists are to share in the growth and development, but to what extent they will share will be influenced to some extent by the interest and zeal they show.

It has long been obviously true that a very imperfect use is being made of the great mass of practical entomological knowledge that has been accumulated. Remedial measures have been worked out for many of our more common insect pests, but, in many if not in most cases, these remedies are not put into general operation. As a rule the farmer recognizes and knows the proper treatment for only a very few of the chief insect offenders and the ones he does know are generally those which if left uncontrolled would very seriously affect his crop. In other words, he uses remedial measures only when driven to it and often overlooks the more obscure injuries which nevertheless greatly reduce his profits. Many a farmer has grown and harvested a crop and placed the returns in his bank without ever becoming aware that his profits were less than they should have been. A striking instance of a farmer having overlooked a serious injury to his crop may be related from the writer's experience. Reports of rather extensive damage to fall wheat due to the army cutworm (*Chorizagrotis agrestis* Grote) had been coming to the office from a certain part of Montana. Knowing that a certain man who lived in town had a large field of wheat in that neighborhood, he was asked if his crop was being injured and he replied that he had been at the farm and examined the grain the previous day and found no injury being done and no cutworms. In passing the field the day following the writer examined it for the insects and found that injury was being done throughout the field though no spots had been made bare. It was estimated that there were about two cutworms present for every square foot of surface and in some parts of the field the crop had been very seriously injured.

There can be no doubt that very much good has been accomplished through the agency of bulletins and circulars, correspondence, farm papers and institutes, but it is equally certain that farm practice may further be greatly benefited by putting into operation in a far greater degree the results of entomological investigations. Bulletins reach the farmer irregularly and if read are not often preserved. Many farmers dislike to write letters and find it difficult to thoroughly state their problems. Institutes are few in number, often come at a busy time of the year and frequently are held at a considerable distance from the home. The results of a survey made by the Bureau of Plant Industry and published in Circular No. 117 showed the farm papers to be the most popular among the various helpful agencies, but specialists are often disheartened as they observe how inadequately these papers meet the requirements. Entomologists have observed in the papers not only grave errors, but discussions that do not apply at all to the conditions that the readers of the particular paper have to contend with. If the entomologist criticizes he is asked to prepare more articles

which only further indicates that the public is in need of reliable information. Of all of these agencies it may be said that they are largely lacking in the element of vital contact with the farmer's real needs.

Our knowledge of insects and of means of control have gone far in advance of the farmer, and entomologists, in particular, are in need of such a means as has been provided for disseminating knowledge of insect control and demonstrating its value. We may or we may not approve entirely of the details of the method that is being so rapidly established but it has come to stay, apparently, and we may as well face the fact and prepare to meet the conditions.

The Smith-Lever Act specifies that its benefits shall be applied through the college or colleges now receiving the benefits of the first and second Morrill acts, that is, the agricultural colleges, which in some states are separate institutions and in some are maintained as colleges in the state universities. The problems incident to the new work, therefore, come to college rather than to experiment station officers. The act is broad in its provisions with respect to how the funds shall be made effective. Nobody knows what the completed organization shall be or how the many questions that are arising are to be met. Already, however, the states have in large measure committed themselves to the employment of resident advisers in the counties. These have received various names, including farm demonstrators, county agriculturists and county agents. For the purposes of the remainder of this paper they are called "county agents" or "agents."

The college departments' relationship to the county agent needs to be carefully defined. In the nature of the case the men to fill these county positions must be general in their training and experience. They cannot be specialists, though it is entirely possible that as the system develops special agents or specialist agents may be employed to meet local requirements. These, however, will be few in number, at least for many years.

Yet these generally trained men will be the ones to whom in large measure the requests for information regarding the identity, life-histories and control of insect pests will come. They are the ones who will be in contact with the people. In this respect, the system is weak but under the circumstances it is the best that can be provided and with proper coöperation good results may be secured. The county agent will need the help and backing of his college and a clear understanding of what is expected of him, for he has little precedent for his guidance and since he is the mouth-piece of many college departments and is expected to teach truly their doctrines, he has, in a sense, many masters.

His relationships with the home institution will necessarily be very complex and we can do little more at the present time than to state some general observations. He should consider himself to be not a dissociated, independent factor, but rather a medium of communication between the specialist and the farmer. He should realize that he is to dispense facts and not opinions and should early learn to practice the delicate art of saying, "I don't know" when confronted by questions that go beyond his knowledge or experience. He needs to be reinforced by the assurance that questions referred to the college will be answered promptly.

For his part the specialist should, through deliberate plans, make a renewed effort to be helpful to the farmer through the agent. This point is discussed more at length below. It is apparent that close relationships and a complete understanding should grow up, paving the way for the quick settlement of questions that must arise.

Numerous questions are arising. Following are some examples. Should agents train their farmers to make requests for information of the home institution through them? To what extent shall agents first get the approval of the home departments before starting special campaigns? Shall copies of the agents' periodic reports be referred to the departments? It is believed that all such questions as these may be satisfactorily worked out by an observance of the general principles outlined above.

In the past in many states a single entomologist has alone, or with little assistance, carried all four branches of the state's entomological service, namely, investigation, teaching, extension and law enforcement. That day is passing. The agricultural colleges generally retain one man as head of all entomological work in the institution and he, yielding to the dictates of efficiency, is finding it necessary to employ special investigators and special teachers.

It seems desirable, first, to recognize as tenable the primary divisions of the work suggested above, not that we are called upon to at once, or perhaps ever, draw hard and fast lines of separation, but because as development occurs and new men are added, specially qualified assistants may be secured and all of the details of organization may be planned to harmonize.

It is believed that at the outset we should recognize the extension work as a distinct and important branch of the state's work in entomology rather than to attempt to accommodate the new duties among our miscellaneous activities. Each state will need one man or more whose duty it is to serve the needs of extension work and as entomologists generally now recognize teaching, research and law enforcing as natural branches, they will probably some day recognize extension work. It

is not unlikely that at some future time when there are a considerable number of entomologists who are especially interested in extending knowledge of economic entomology, there will be established a division or branch of this Association to facilitate interchange of ideas. For our present purposes we may call him the "extension entomologist." Some states have had field representatives who have been of much service in keeping the home institution in touch with field conditions. These men have been charged particularly with getting information from the field, rather than with giving it to the farmers. It will be but natural to combine in the duties of the extension entomologists the work which some states have had the field men do; that is, as they are about the state do special errands, such as collecting specimens, materials and notes for the use of the research men and teachers. He can be of great service in numerous ways. His special interest will be to gather and systematize information from all sources, but particularly from his co-workers in his own state and not only get it to the farmer, but get it into practical use by the farmer. While his particular interest is to effectively extend knowledge he need not and should not lose the same scientific spirit that now actuates entomologists. We wish the results of our investigations to be taken to the farmer by the entomologist and in the same spirit as in the past. It could not be as effective to have entomology combined in one man with some other special line, perhaps plant pathology, though for a few years we may be called upon to accommodate ourselves to such adjustments. We should, as soon as possible, have our own representatives in the field.

Farming interests have suffered heavily in the past through the experiment station's being uninformed or poorly informed concerning insect injuries that are taking place. The extension entomologist may, through his county agents and through his own observations, do much to prevent widespread damages. In Montana this spring we experienced a widespread and very serious outbreak of army cutworms. In one county, alone, it was estimated that 12,000 acres of fall grain were eaten off, requiring replanting. We have no way of knowing just how many acres of grain were destroyed in the whole state, but it is probable that 100,000 is not very far from correct. Beside this, many thousands of acres were saved through the timely use of remedies which the state entomologist recommended. Much more could have been saved if the office had been informed in time. If the agents had been trained to observe the first indications of the presence of this insect or if the department had had a representative in the field, we should have received earlier advice.

It is too early to completely outline the duties of the extension entomologist, but some things he should do are already apparent. In

the first place, the agents will naturally apply directly to him for information and he will be in charge of the department's relationships with agents. He will naturally travel much, going from one agent to another and helping in the solution of local problems, looking into outbreaks and aiding in their control. He will naturally aid in survey work in states where this is under way and will contribute to the building up of the department's collections.

The extension entomologist should be much in demand for lecturing at institutes, in short courses at and away from the home institution and in high schools. In this connection he may equip himself with charts, lantern slides, demonstration materials and life-history exhibits. He may prepare many circulars of information and articles for newspapers.

In placing emphasis at this time upon the importance and utility of extension service in entomology, the writer wishes particularly to be not understood as losing a sense of perspective or of losing sight of the importance of the other branches. This new movement should be received and adopted by official economic entomologists as a unit to be placed among the other units in the state's entomological system. It will have, therefore, its organic relationship to the other branches of the service. We cannot at this time enter upon a full discussion of these matters, but some comments seem to be timely.

We have mentioned a primary classification of official entomological service. The fundamental or central branch is undoubtedly research and an effective state organization will necessarily give a large place to investigations which will go deeper and deeper into the unknown and more and more illuminate the whole system. The main interests of entomological departments will undoubtedly continue to be research and teaching. The teacher of entomology, the extension worker and the inspection official must always look to the investigator to supply that element which gives stability to their work. At the same time, in whatever branch of the work one finds himself, it is believed that it is necessary that he keep alive in himself the true spirit of the scientist, a love for the truth, a worthy desire to uncover the unknown and add to knowledge. The extension entomologist can continue safe and reliable only as he keeps in touch with the on-movement of his science. Accordingly, he should be given an opportunity to a limited extent to work out some of the problems that arise in connection with his own work; that is, do some investigational work. He should be always essentially an entomologist even though engaged in extension work.

Another point that should be made is that, while in the past station entomologists have been expected quite generally to attend to all mat-

ters of insect control, such as correspondence, lecturing and newspaper writing, they should now be largely relieved of these extras. There has grown up a strong tendency toward confusing extension work and experiment station work. The farming public has needed help and the station has been the natural place to go for it. Yet the federal acts by which the experiment stations are endowed do not authorize extension work. When the results of investigations are published, the experiment station's responsibility ceases and the investigator, paid from federal funds, who turns aside from his studies to lecture to farmers, to write for the farm papers or to aid farmers by correspondence, if he does so to the extent of reducing the effectiveness of his researches, is not only infringing on the law, but reducing the efficiency of the organization. The situation has been met in the past by having the specialist's salary paid in part from state funds over which federal authorities have no jurisdiction. This has resulted in interruptions and delays with which we are so familiar. The most serious effect has been perhaps a reduction in efficiency in research workers. There has grown up a tendency to accept and adopt standards which are lower than can be attained by allowing investigators to pursue their studies without serious distractions.

In conclusion, emphasis should be placed on the fact that the passage of the Smith-Lever Act and the events which have grown out of it are of the greatest importance to economic entomologists. A new era of far-reaching developments seems to be indicated. In the past, entomological work has not received the public recognition that its importance merits, largely because of widespread popular ignorance of the subject, and if entomologists will be quick to see the significance of the new extension movement and to act, the scientific interests which we represent may be greatly benefited.

The most immediate result should be an increased demand for well-trained young economic entomologists. Many new positions should be opened during the next few years as the extension funds become available and this will affect teachers and research men as well as extension workers. This is clear when we stop to think that, in preparing men for the extension service, the teaching department will be called upon not only to teach entomology to the men who will become the county agents, but to train those who will serve as extension entomologists of which there should be eventually many.

Having one or more trained observers out in the state much of the time will put the college in touch with problems that require attention and will suggest lines of research. These problems will naturally be the ones that the farmers are interested in and a greater measure of sympathy and coöperation between the farmer and entomologist should

result. In Montana, we have already felt a marked increase in the demands for help from the farmers. These are coming partly through the agents, and the agents are always glad to coöperate in these matters, so far as they are able, for they feel that in this way they can show positive, tangible results, leading to outspoken approval from the farmers.

Another result should be that we will fare better at the hands of the legislatures in all of our funds, but particularly in the appropriations for research. This should be brought about through the farmers and general public becoming better acquainted with the methods of work, aims and results of entomological research.

DR. L. O. HOWARD: The address is now open for discussion.

MR. A. F. BURGESS: The point made in the address in regard to securing well-trained entomologists, particularly in connection with demonstration work on the farm, merits careful consideration. It would seem well to keep this matter constantly in mind when positions are being filled.

DR. L. O. HOWARD: One of the strong points in this address is that it looks forward to the future. Aside from being concerned with present conditions, it takes up in a comprehensive way future conditions and prospects.

At the conclusion of the discussion the session adjourned at 11.30 a. m. in order that the Pacific Slope Association of Economic Entomologists might hold a brief session.

Afternoon Session, August 9, 1915

The session was called to order by Vice-President Cooley at 2 p. m. This was a joint meeting with the Pacific Slope Association.

MR. H. F. WILSON reported that at the Session of the Pacific Slope association a committee consisting of Mr. E. D. Ball and Mr. E. O. Essig had been appointed to consider what steps could be taken in order that the Pacific Slope Association might affiliate with the American Association of Economic Entomologists. He requested that a committee of two members from the latter Association be appointed to consider the matter with the committee already appointed.

It was voted that a committee be appointed, and the chair selected Mr. C. P. Gillette and Mr. A. F. Burgess to represent this Association.

The following committee on resolutions was appointed by the chair, Messrs. E. A. Back, F. C. Bishopp and A. L. Melander.

VICE-PRESIDENT COOLEY: The first paper on the program will be presented by Mr. Geo. P. Weldon:

THE WOOLLY APHIS AS A PEAR PEST

By G. P. Weldon, *Sacramento, Cal.*

(*Withdrawn for publication elsewhere.*)

Vice-President Cooley: The next paper will be read by Mr. O. H. Swezey.

SOME RESULTS OF THE INTRODUCTION OF BENEFICIAL INSECTS IN THE HAWAIIAN ISLANDS

By Otto H. Swezey,

Entomologist, Experiment Station of the Hawaiian Sugar Planter's Association, Honolulu, Hawaii

Only a very few of the native insects of the Hawaiian Islands have become injurious to cultivated crops or plants. The insect pests occurring there are in most cases foreign insects that have arrived through the channels of commerce. The promiscuous importation of fruits, seeds, trees, plants, etc., from all parts of the world has been the chief way by which the numerous insect pests have gained access to these islands. One has but to observe the profusion and variety of trees, shrubs, and plants in the public parks and private grounds of Honolulu to realize to what extent this has been carried on, for in all of this there is only an occasional native tree or plant to be seen.

The most of this introduction of trees and plants was done before the present rigid system of plant inspection and quarantine against insect pests was instituted, and the insects have come along freely with their host plants. There are about seventy-five species of scale insects known in the islands, none of which are native, but all have been brought in in this way. The sugar cane leaf-hopper, too, so well known from its having caused such heavy loss to the sugar industry, is a striking example of a pest arriving with its host plant, coming in as it undoubtedly did in the egg stage in importations of cane cuttings for planting.

Many insects have arrived in other ways through the channels of commerce, as in packing, in soil about the roots of plants, along with domestic animals, chance travellers on board vessels, etc. Some, not pests in their home country, have become pests here when established in the absence of their natural enemies. Observations on this line have led to the practice which is now so prevalent of searching for the

native home of a pest and making a study of its natural enemies for the purpose of introducing them to the countries where the insect has become established as a pest.

Considering its size, Hawaii has probably accomplished more in the way of combating insect pests by the introduction of their natural enemies than has any other country. The first introduction of beneficial insects in Hawaii was when, following his remarkable success in the introduction of an Australian lady-beetle (*Novius cardinalis*) into California to destroy the cottony cushion scale, Mr. Albert Koebele also introduced it here, where it soon reduced the same pest to such scarcity that it is no more a menace to the trees and plants previously affected. A few are to be seen now and then on various plants and trees, but the lady-beetle is in such control that no serious infestations now occur.

This introduction was as early as 1890, and shortly after, in 1893, Mr. Koebele was engaged by Hawaii to continue this work of finding and introducing beneficial insects. Many of the first successful introductions were lady-beetles. About a dozen different species were successfully introduced by 1896, mostly from Australia and the Orient. Among these were *Cryptolæmus montrouzieri*, *Rhizobius ventralis* and *Rhizobius toowoombæ* which feed on various species of mealybugs; *Cælophora inequalis*, *Platyomus lividigaster*, *Scymnus læwii* and *Scymnus notescens* feeding on plant-lice; *Orcus chalybæus* and *Chilocorus circumdatus* feeding on scale insects. Many other lady-beetles have been tried, but not all were successful. Some failed to become established, and others, although established, failed to increase sufficiently as to be of noticeable use. However, the combined work of all mentioned above has reduced greatly such pests as mealybugs, scale insects and plant-lice.

Thirty or more species of hymenopterous parasites have been introduced, also, to prey on this class of insect pests. The lady-beetles are often seen busily feeding upon their respective hosts and the general public recognizes them as beneficial; but the parasites, often very minute, are seldom seen, and hence their usefulness is not generally known by people unfamiliar with their habits. Their presence may be determined by close examination and finding the tiny round holes which they have gnawed in the scale insects, in emerging from them, after completing their transformation in the place where they have been feeding on the living bug, or its eggs, beneath the scale. These scales with the tiny holes may often be found in great abundance on scale-infested plants, mute evidence of the usefulness of the parasites.

Among the most valuable of the introduced Coccid parasites are: *Encyrtus fuscus*, *Blepyrus marsdeni*, *Microterys flavus*, *Apentelicus*

kotinskyi, *Adelencyrtus odonaspidis*. *Scutellista cyanea*, *Tomocera californica*, *Tomocera ceroplastis*, *Aneristus ceroplastæ*, *Coccophagus orientalis*, *Coccophagus lecanii*, *Aphelinus diaspidis* and *Aspidiotiphagus citrinus*.

The usual sequence of beginning, increase and decline of an outbreak of mealybugs or plant-lice is often to be seen. The pest may get a start at a time or in some place where there are none of its enemies, and may increase considerably before being found by any lady-beetles or parasites. These latter, having arrived in small numbers, begin to reproduce, and after a few generations increase sufficiently to become effective in checking the increase of the pest; then, after still further increase in numbers, finally exterminate the pest entirely. After such an outbreak of mealybugs, the adults and larvæ of the lady-beetle, *Cryptolæmus montrouzieri*, may be seen in thousands, and their pupæ also in large numbers where the larvæ have congregated in some sheltered place for pupation.

An occasional occurrence of this kind serves to illustrate the usefulness of the parasites and lady-beetles, and also shows what conditions might prevail continuously if these pests were not kept pretty well in check for most of the time. More of these lady-beetles and parasites would be useful, and the entomologists of Hawaii avail themselves of every opportunity of securing them.

Leaf-roller Parasites

In 1895, among other parasites that Mr. Koebele introduced from Japan were *Chalcis obscurata* and *Macrodyctium omiodivorum*, which attack the pupæ and caterpillars of the leaf-rollers on sugar cane and coconut palms. These two parasites do a great deal of good in killing off these leaf-rollers. *Chalcis obscurata* also parasitizes the pupæ of several other leaf-rollers of fruit trees and garden plants, among them *Archips postvittanus* and *Amorbia emigratella*, once very abundant but now not very injurious.

Macrodyctium omiodivorum is a small Braconid and chiefly attacks the larvæ of the sugar cane leaf-roller, *Omiodes accepta*. This is a native moth whose larvæ normally feed on grass and are always to be found in grassy regions, especially at elevations of 1,000 to 3,000 feet. Sugar cane fields in the vicinity of such regions are often subject to severe attack and considerable injury by these caterpillars. Since the introduction of the Braconid, the leaf-rollers have been held in check in the cane fields, or if outbreaks occur at any place they are soon found by the parasites, which, having a very short life-cycle, are soon able to increase sufficiently to check the pest.

Lantana Insects

Another phase in the introduction of beneficial insects was the introduction of the lantana insects by Mr. Koebele in 1902. He made a thorough study of the insects preying exclusively on lantana in Mexico, to ascertain which could be safely introduced to serve as a check on this plant in Hawaii. Among the many species of insects studied, eight were successfully introduced and finally spread all over the islands. Of these insects, the maggots of the little black seed-fly (*Agromyza* sp.) destroy the seeds in the growing berries; the larvæ of two moths (*Platyptilia pusillidactyla* and *Crocidosema lantana*) feed in the flower clusters, thus helping to prevent the formation of fruit; the caterpillars of two butterflies (*Thecla echion* and *Thecla agra*) feed on the flowers; the larvæ of a tiny moth (*Cremastobombycia lantanella*) mine the leaves, thus causing them to become ineffective in the service of the growing plant; a small bug (*Teleonenia lantanæ*) feeds abundantly on the underside of the leaves, causing them to die and fall off; a gall-fly (*Eutreta sparsa*) produces large swellings or galls on freshly-growing shoots, thus checking the normal growth.

The growth of lantana has been greatly checked by all these insects, and in some places their effect, in connection with climatic conditions, has killed it off entirely. The greatest benefit derived has been from the destruction of the flowers and seeds, so that land once cleared of lantana does not again become invaded by it; whereas formerly on the cattle ranges a great deal of expense was involved in continuously rooting out lantana, for it was always being reseeded by birds dropping the seeds broadcast. Now, very few seeds are formed, as many of the flowers are destroyed by the larvæ of the two butterflies and the two moths above mentioned, and what seeds do start to grow are mostly eaten by the larvæ of the Agromyzid fly.

There has been considerable fear on the part of some that the introduced lantana insects would become pests on other plants, especially when the lantana became scarce or killed out, but such has not been the case. None of these insects have ever become injurious to any cultivated fruit or plant, and it is indeed doubtful if any such plant has been in the least attacked by them. It is of interest to note in this connection that at the time the Mediterranean fruit-fly first became known in Honolulu, an opinion expressed by many of those ignorant of the ways of insects, was that the "lantana fly" had changed its habits and turned into the fruit-fly, thus becoming a bad pest. Some were so thoroughly imbued with this idea that it was impossible to convince them of their error.

Sugar Cane Leaf-hopper Parasites

The most noted case of introduction of beneficial insects in Hawaii occurred in 1904–05, when Messrs. Koebele and Perkins introduced from Australia and Fiji the egg-parasites for the sugar cane leaf-hopper, *Perkinsiella saccharicida*. These were three Mymarids (*Paranagrus optabilis*, *P. perforator* and *Anagrus frequens*) and a Chalcid (*Ootetrastichus beatus*). Attempts were made to introduce others of the many parasites that were found preying on leaf-hoppers in Australia and Fiji, but these egg-parasites and a Dryinid were the only ones that were successful.

They soon became established and were spread throughout all the sugar plantations, and within two years had made such a reduction in the number of leaf-hoppers in the cane, that there was already an appreciable amount of benefit derived, and after two more years there was comparatively little complaint of injury or loss by the leaf-hoppers. Sugar cane was again grown without the severe setback which young cane was always subject to when the leaf-hoppers were at their worst, and which often resulted in ruining whole fields; in one instance almost all the fields of a large plantation of 9,000 acres.

The year preceding the establishment of the parasites, the estimated loss from the leaf-hopper amounted to $3,000,000 for all the plantations of the islands, and the sugar industry was threatened with ruin. After the establishment of the parasites, this annual loss was diminished yearly, until in a very few years the loss by leaf-hoppers was considered negligible. Yet even now, after ten years, there are occasional severe local outbreaks of the leaf-hopper, when whole fields or spots in certain fields suffer considerably from their attack; but this is usually only temporary, and there are no general outbreaks.

Of the different parasites, one of the egg-parasites (*Paranagrus optabilis*) has been the most useful one. The others are not always to be found everywhere, but this one is always found anywhere and everywhere that there are any leaf-hopper eggs for it to breed in. It is usual to find 50 per cent or more of the eggs parasitized by it. When the shortness of its life-cycle is considered, it being three weeks as compared with six weeks or more for the leaf-hopper, it is seen what advantage it has in checking the latter. It has been the main factor in this natural control of the leaf-hopper, though the other introduced parasites and some local parasites and predators have been very useful and played an important part.

Cane Borer Tachinid

Another remarkably successful parasite introduction was a tachinid (*Ceromasia sphenophori*) parasitic on the sugar cane weevil borer (*Rhabdocnemis obscura*). This was brought from New Guinea by Mr. F. Muir in 1910. An account of his search for parasites for the cane borer, the finding of this tachinid and its introduction to Hawaii are given in the Journal of Economic Entomology, Vol. VII, page 455, 1914. Within two years the tachinids had been distributed to nearly all plantations and well established in many of them. Nearly five years have now elapsed and the beneficial results are very apparent. Already, in 1913, the tachinids had become sufficiently abundant to cause a considerable reduction in the number of borers in the cane, and a consequent diminution of damaged cane resulting in an increased yield of sound cane per acre. This was especially noticeable in those plantations where the pest had been the worst, and where on this account efforts to establish the tachinids had been concentrated at the outset. On one of these plantations where the manager was keeping definite records, and the usual infestation by borers was 30 per cent of the canes, it had dropped to an infestation of only 12.77 per cent. This has resulted in a greater yield of good cane per acre, and at the same time the quality of the juice in the cane has been so much improved that more sugar is produced per ton of cane. To use figures from the plantation reports: it now requires 1.67 tons less of cane to produce one ton of sugar than it did formerly.

Another plantation, that has been similarly benefited, reports that its yields have been increased by a little over two tons of sugar per acre. If the price of sugar be taken at an average of $75 per ton, this would mean a saving of $150 per acre, and the plantation harvesting 1,000 acres annually would have a saving of $150,000.

Not all plantations have been benefited to the extent of these used as illustrations, for not many were so severely infested by borers as these were, but many have been very considerably benefited. The total saving to the sugar industry of the Islands would amount to many thousands of dollars annually. It is significant that the crop of sugar in 1914 was 21,780 tons greater than any previous crop in the history of the sugar industry in the Hawaiian Islands.

Present conditions indicate that the tachinids have reached their maximum efficiency, for they are now less abundant in the fields than they were shortly after the time when they became generally spread. This is by reason of the reduction in the number of borers. Where the borers were formerly most numerous, it gave the tachinids oppor-

tunity to increase until for a time they were very abundant, but later became scarce, corresponding to the scarcity of the borers brought about by them. In many places it is now difficult to find injury by borers where formerly much cane was injured, and similarly the tachinids are difficult to find in these places.

Fruit-fly Parasites

Several species of fruit-fly parasites were brought from Africa and Australia by Dr. F. Silvestri in 1913. Some of these were reared successfully in large numbers and widely distributed. The following year two species (*Opius humilis* from Africa and *Diachasma tryoni* from Australia) were found to be established and quite widely spread. In 1914, Mr. D. T. Fullaway brought several more species of fruit-fly parasites from Africa, which have likewise been reared in large numbers for distribution. It has not yet been long enough to expect extensive results from these introductions, but there is hope that when several of them are well established and generally spread much good will result.

In this short paper only the more important of the introduced beneficial insects have been mentioned. There have been many others of less importance, either by reason of their attacking less important insect pests, or that they failed to increase in sufficient numbers to be of significant value. There have been many tried which for climatic or other reasons entirely failed to become established. Many attempts have been made to find and introduce useful natural enemies for the horn-fly on cattle, but none of them so far introduced have brought about any noticeable general reduction of the pest.

The entomologists of Hawaii, encouraged by those which have been successful, are continuing in this method of combating insect pests, and from one or the other of the institutions there, projects for the introduction of more beneficial insects are continually being carried on.

Mr. E. D. Ball: What is the native home of the sugar cane leaf-hopper?

Mr. O. H. Swezey: It was supposed to be in Australia. Parasites were secured from there, also from Borneo, New Guinea and Fiji. We are not certain of the native home of the leaf-hopper. It is not a pest in the countries mentioned.

Dr. L. O. Howard: Hawaii has done more than all other countries put together in the matter of introducing parasites successfully. The introduction of insects to feed upon weeds or other plants is a dangerous experiment and it is very fortunate that it turned out so well in this case.

VICE-PRESIDENT COOLEY: The next paper will be presented by Mr. Leroy Childs.

SPRAYING NOTES ON THE CONTROL OF THE FRUIT TREE LEAF-ROLLER IN THE HOOD RIVER VALLEY

By LEROY CHILDS, *Research Assistant, Department of Entomology, Oregon Agricultural College, Corvallis, Oregon*

In the face of the already valuable information that is available on the life-history and the control of the leaf-roller, this paper and the work that it represents might appear to some as superfluous. In citing the literature, however, I find little or no published experimental work dealing with the control of this serious and numerically increasing apple pest on the Pacific Coast. A still more important point which made experimentation, at least with the oils, imperative was to determine if possible what influence spring applications of oils have on the adhesive properties of fall applications of Bordeaux mixture. In the Northwest we have a very serious apple disease known as apple tree anthracnose, for control of which Bordeaux is applied before the early rains in the fall. It has been suggested, and seems, indeed, quite possible, that there may exist some such condition, information relative to which is desired before the general use of oil can be recommended. The anthracnose spray has not been applied with the result that a report on this point is impossible at this time. The leaf-roller, however, has passed through its period of activity for this season and the data gathered relative to its control is complete.

In the Hood River Valley the presence of the apple leaf-roller is not general. The limits of the present infestation are well defined, comprising at the present time some five hundred or six hundred acres. A yearly expansion of these limits occurs and the losses are increasing, with the result that the orchardists are planning a vigorous campaign against the pest next year.

At no time in Hood River has the infestation occurred to such an extent as to cause noticeable defoliation; occasionally the tender foliage of growing terminals is severely injured but in no place has there occurred the complete defoliation that has been reported in different sections of the East. The injury to the fruit, however, in several orchards where extensive countings were made produced surprising information. The losses incurred by the feeding worms often approached 40 per cent of the entire crop. It was found that the injury was even more severe on trees in light bearing, where the percentage of injury amounted to

more than 50 per cent. This loss, together with the other losses that must be considered in the form of scab, codling moth, bruises, etc., make it imperative that some means be employed in reducing this waste.

In order to determine the most advantageous method that could be employed under Hood River conditions, a series of experiments embracing lead arsenate in various strengths, crude oil emulsion, kerosene emulsion, distillate emulsion and a miscible oil were used during the past spring.

Owing to the fact that it is necessary to make four or five spring and early summer applications of a fungicide for apple scab control in Hood River, lead arsenate, if efficient, seemed to offer the least expensive plan (at least from the standpoint of labor) in bringing about leaf-roller control, for this material is usable in combination. Six different plans of procedure were outlined. Lime-sulfur was the fungicide employed throughout the season. Spraying in the spring began in what is termed at Hood River the delayed dormant spray, or an application applied at a time when the more advanced foliage has reached the size of squirrels ears. At this season it was very difficult to find any hatched leaf-roller eggs.

The orchard in which the experiments were conducted is planted to Spitzenburg apples which are now about twelve years old. Two rows across the orchard were used in each experiment. Between each was left one as a check. In referring to the table it will be seen that countings from each of these rows serve as a check on two experiments. The degree of infestation, based on the presence of egg masses, indicated that it was at least typical of the conditions as existing in the valley. A power sprayer fitted out with a "New Way" engine and two leads of hose was employed throughout the season in applying the materials. Frembo nozzels with a medium sized hole in the disc were used.

Two essentials were considered in the scheme of the arsenate experiments: first, to determine, if possible, the least amount of poison that must be used in bringing about control, and second, to determine if possible the insect's most susceptible period to poison.

With these thoughts in mind, six experiments were outlined. Referring to the table it will be seen that in all six experiments, lead arsenate was used in the delayed dormant application, that the poison might be present as the worms hatched. In the delayed dormant spray lime-sulfur was used at the rate of 1 to 18 throughout. To this fungicide was added in experiment 1 and 3, arsenate of lead (paste in all cases) at the rate of 2 pounds to each 50 gallons; in experiment 2 and 4, 4 pounds to each 50 gallons and in experiments 5 and 6, 6 pounds

to each 50 gallons of water. A large number of egg masses were examined at this time; none of the eggs were found to be hatching, the embryonic development was far advanced. The date of this application was April 3.

A second or "pink application" (*i.e.*, at the time the flower clusters were beginning to show pink) was made on April 14. The fungicide employed was as in the first, lime-sulfur, used, however, in a more dilute ratio, 1 to 27. The arsenate of lead was omitted in experiments 3, 4 and 6. The poison applied at this time in experiments 1, 2 and 5 was in the same strengths as used in the delayed dormant spray 2, 4 and 6 pounds respectively. To determine the condition of the eggs, a large series of egg masses were examined and it was found that hatching was actively taking place, 58 per cent of the worms having emerged. On the 20th of April, or four days later, no unhatched eggs could be found. At this time a large portion of the foliage was still well covered with the poison. From these observations it is clear that material placed upon the trees during the time that the blossom buds are showing pink is most advantageous with reference to the emergence of the worms.

Unfortunately, a series was not run in which a "pink" spray only was used; a series of this sort would undoubtedly show more clearly the relative values of this application than can be shown with the data at hand.

At the time of the calyx application, May 1, a large majority of the worms were found beneath the folded, web-covered leaves and so located that their food was protected for the most part from materials that could be applied in the form of spray. In view of this fact, a codling moth spray of 3 pounds to 50 gallons only was added to the lime-sulfur 1 to 36 in all of the experiments For fear of codling moth infestation, the check rows were sprayed at this time, also. The data gathered from the counts made on the check rows, consequently, hardly give accurate information relative to the losses that might occur should all spraying be omitted. In looking over the experiments after the calyx spray, many ailing worms were found and others that were dead, all of which seems to indicate that, where available, this strength is sufficient to destroy the worms.

The fourth spray of the season or the second codling moth spray was applied May 29. This consisted of arsenate of lead, 3 pounds to 50 gallons of water, plus the lime-sulfur 1 to 30. Fruit only received attention at this time, all of which were thoroughly covered. In early June a great deal of fruit injury was noted taking place and in many cases the small apples were found largely consumed. The worms in folding and rolling the leaves often incorporate many of these little

apples, and those so surrounded with foliage are invariably ruined. This feeding on the fruit, though often not very extensive, devitalizes the apples to such an extent that they stop growing and drop. On account of this existing condition, it was thought best to check up the experiments as soon as the feeding period of the insects was over rather than waiting until harvest time. In so doing, thinning of the fruit was permitted on the plats where it was found to be necessary.

A thousand fruits or thereabouts were counted in the various experimental plats and checks. These were made from representative trees chosen at random in the plats. In comparing the results that were obtained, it is clearly indicated that none can be pronounced as efficient in controlling the leaf-roller, though some benefit may be derived from as weak application as 2 pounds to 50 gallons. In experiment 1, where 2 pounds to 50 gallons were employed in the delayed dormant and in the pink sprays, a benefit of 9 per cent was obtained when compared with the check. Contrasting this experiment with 3 in which the lead was omitted in the pink spray, the results clearly show the time at which the poison is an active agent in destroying the worms. In this experiment there is only a 3 per cent difference between sprayed and unsprayed fruit. The inefficiency of the delayed dormant spray is more clearly shown in experiment 4; here 4 pounds of the lead arsenate were used to 50 gallons. The fruit count shows a 27 per cent loss on account of roller injury or five tenths of one per cent less than the check. This is 2.5 per cent more injury than was obtained where the weaker arsenical was used. This discrepancy falls within that allowed for experimental error.

The extra two pounds of lead to 50 gallons of water in experiment 2 decreased the fruit loss by 3.8 per cent, giving a total fruit injury in this experiment of 15 per cent or a reduction of a little less than half of the losses that occurred on the unsprayed trees.

In experiment 5, where lead arsenate at the rate of 6 pounds to 50 gallons was used in the two early sprays, more encouraging results were obtained. Even with this heavy dosage, however, 11 per cent of the fruit was found to be damaged. On trees heavily loaded with fruit, a loss of this percentage would not be very severe as a large part of this could be overcome by judicious thinning. In years of a light crop, however, a condition which exists this year, and where all of the fruit should be retained, more efficient remedial measures than arsenical poisoning should be employed. Unfortunately, experiment 6 was conducted on Johnathans, a variety which is not subject to severe attack, in Hood River at least, by the roller, so that comparative data as noted in the other experiments were not obtained.

In times past, oils have been used by local growers in an attempt to control the leaf-roller, with rather indifferent success. Owing to existing conditions it was thought best to test out a series of materials. Four oils were used in eight experiments as follows: kerosene emulsion, 18 per cent, distillate emulsion, 18 per cent, crude oil (Balfour Guthrie Co.) in the ratio of 1 to 12 and 1 to 15 and miscible oil No. 1, manufactured by the above company, in four strengths, 5, 6, 7, and 8 gallons to the 100 gallons of water.

Some of the pioneer workers in leaf-roller control have at various times recommended kerosene as an effective means of destroying the eggs of the leaf-roller and the 18 per cent emulsion of this material was placed on the trees with confidence that many eggs would be destroyed. The trees were thoroughly covered, in fact drenched, 5 to 6 gallons of the material being applied to each tree. When a count of the eggs on the experiment and check was made, it was found that a larger portion of the eggs on the sprayed trees, or 96.4 per cent, hatched as compared with 95 per cent hatched on the control trees. A duplication of this experience was encountered with the distillate; here again no ovicidal properties were found to exist when applying an 18 per cent emulsion. The trees were examined the day after the material had been applied and it was found that nearly all of the evidences of the oil had disappeared. When used within the bounds of economy, both of these materials are lacking in sufficient penetration qualities to be considered a means of destroying leaf-roller eggs.

The results that were obtained with the crude oil proved disappointing, also, from a point of control. The material was used in two strengths, at the rate of 1 gallon of oil to 12 gallons of water and 1 gallon of the oil to 15 gallons of water. These emulsions were applied May 27. The variety of trees in the experimental plats were twelve-year-old Spitzenburgs on which many egg masses could be found. On the day that the spray was applied the more advanced buds were noted already burst and some of the first leaves were out. Upon examining the plats a few days later many of the early leaves were found to be injured. They, for the most part, were not burned but seemed to be stunted and had an oily appearance for several weeks, a condition which was not observed in the other experiments. This greasy condition existed on much of the foliage for several weeks, retarding and causing a malformation of the leaf growth on many of the trees. While the crude oil was being applied, a very strong wind was blowing making thorough work very difficult. This may have affected the results to a slight degree for a few egg masses here and there were found to have been slighted. In experiment 9, or where the 1 to 12 formula was used, 43 per cent of the eggs failed to hatch.

In the check, 4 per cent only failed to produce worms. In the counts that were made of fruit injury, this 43 per cent killing of unhatched worms made a reduction of only 6 per cent in total fruit losses. On the sprayed plat, 24 per cent of the fruit were damaged while 30 per cent were injured on the control rows.

Nineteen per cent, only, were killed in experiment 10 where the crude oil was used in a dilution of 1 to 15. Here, 26 per cent of the fruit were found to have been injured by the worms as compared with 30 per cent in the check. To have obtained good results, a strength of at least 1 to 8 should have been applied. It is clear that an application in this strength should be made only when the trees are entirely dormant.

The results that were obtained from the miscible oil experiments were highly satisfactory in every way. In fact, the figures show such complete efficiency that those skeptically inclined might look upon them with suspicion. As has been stated before, the miscible oil was applied in four strengths, 5, 6, 7, and 8 gallons to the 100 gallons of water. Owing to the fact that a delay occurred in the receipt of the material, followed by rainy weather, the emulsions were not applied until April 3, at which time the trees—of the Newtown variety—were beginning to send out foliage. This foliage development was sufficient to give the orchard a faint green coloration. In a few cases the leaves about the fruit spurs had unfolded to such an extent as to expose the tips of the fruit buds. The trees were thoroughly sprayed, in fact drenched, five to six gallons being applied to each.

On the day following the spraying, the experiments were carefully gone over; little or no foliage injury was observed. Two days later, however, a large amount of foilage burn was found to have resulted. In experiment 11, where 5 to 100 was used, the injury was of little consequence. In the other experiments, the foliage burn was found to increase in direct proportion with the greater strengths of oil used, reaching a rather alarming condition in experiment 14 where 8 to 100 had been applied. In this plat practically all of the foliage that was exposed dried up and dropped off within a week or two. At first it was thought that many of the fruit spurs were killed; the leaves all dropped away but most of the buds continued to grow and the resulting bloom was almost normal though many of the flowers seemed a little smaller than those on the control trees. These were closely watched and soon after the petals fell many of these smaller ones dropped. Upon examining these weaker flowers, the bases of the stems were found to invariably possess a brown discoloration—in some cases they even seemed burned in much the same manner as that found on the leaves. No other injury to the flower buds was

TABLE I. ARSENATE OF LEAD

No. of Exp.	Date of Applications	Materials Used	Trees Sprayed	Spray per Tree	Results			
					Fruit Counted	Sound	Injured	Per cent Injured
1.	1. April 3 2. April 14 3. May 1 4. May 29 Fruit sprayed only	Lime-sulfur 1-18 Arsenate of lead 2-50 Lime-sulfur 1-27 Arsenate of lead 2-50 Lime-sulfur 1-36 Arsenate lead 3-50 Lime-sulfur 1-30 Arsenate of lead 3-50	48 48 40	3½ gal. 3½ gal. 4 gal.	Exp. 1 1,022 CHECK 1,048	828 743	194 305	18.8 29.
2.	1. April 3 2. April 14 3. May 1 4. May 29 Fruit sprayed only	Lime-sulfur 1-18 Arsenate of lead 4-50 Lime-sulfur 1-27 Arsenate of lead 4-50 Lime-sulfur 1-36 Arsenate of lead 3-50 Lime-sulfur 1-38 Arsenate of lead 3-50	50 50 50 50	3½ gal. 4 gal. 4 gal. 4 gal.	Exp. 2 1,062 CHECK 1,048	900 743	162 305	15. 29.
3.	1. April 3 2. April 15 3. May 1 4. May 29 Fruit sprayed only	Lime-sulfur 1-18 Arsenate of lead 2-50 Lime-sulfur 1-27 ONLY Lime-sulfur 1-36 Arsenate of lead 3-50 Lime-sulfur 1-38 Arsenate of lead 3-50	50 50 50 50	3½ gal. 3½ gal. 3½ gal. 3½ gal.	Exp. 3 1,060 CHECK 1,019	800 800	2 0 279	24.5 27.5
4.	1. April 3 2. April 15 3. May 3 4. May 29 Fruit sprayed only	Lime-sulfur 1-18 Arsenate of lead 4-50 Lime-sulfur 1-27 ONLY Lime-sulfur 1-36 Arsenate of lead 3-50 Lime-sulfur 1-38 Arsenate of lead 3-50	50 50 50 50	4 gal. 4 gal. 4 gal. 4 gal.	Exp. 4 1,102 CHECK 1,019	800 800	302 279	27. 27.5
5.	1. April 3 2. April 14 3. May 4 4. May 29 For fruit only	Lime-sulfur 1-18 Arsenate of lead 6-50 Lime-sulfur 1-27 Arsenate of lead 6-50 Lime-sulfur 1-36 Arsenate of lead 3-50 Lime-sulfur 1-38 Arsenate of lead 3-50	50 50 50 50	4 gal. 4 gal. 4 gal. 4 gal.	Exp. 5 1,177 CHECK 1,019	1,017 800	117 279	11. 27.5
6.	1. April 3 2. April 14 3. May 4 4. May 29 For fruit only	Lime-sulfur 1-18 Arsenate of lead 6-50 Lime-sulfur 1-27 ONLY Lime-sulfur 1-27 Arsenate of lead 3-50 Lime-sulfur 1-36 Arsenate of lead 3-50	20 20 20 20	4 gal. 4 gal. 4 gal. 4 gal.	Exp. 6 This application was made on Johnathans, a variety which is not nearly as susceptible to roller attack with a result that no comparative counts were made.			

observed. Many of the small buds on the larger limbs which in time would develop into fruit spurs were killed, with a result that in the forming of new buds and the resulting foliage growth, the development of the leaves on the plats seemed several weeks behind that of the checks. Today, however (July 20) little or no visible difference in the amount of foliage and fruit exists between sprayed and check trees. In fact (perhaps my imagination) many of the sprayed trees appear more vigorous and possess a richer green coloration than is found in the checks. Just what effect this burning of the fruit spurs will have on next year's crop is a point of interest that will be watched keenly during this fall and next spring.

By referring to the table, the results that were obtained in the miscible oil experiments will be noted. Egg counts were made to determine the ovicidal properties of the various strengths, and fruit counts were made to determine the percentage of injury caused by the surviving worms. It might be added at this point that the infestation was not as severe in the oil plats as was found to occur in the arsenate of lead experiments though both series were carried on in the same orchard. The only explanation that can be offered is that the Newtown appears to be more resistant to roller attack than the Spitzenburg. Owing to the fact that it was adjudged unsafe to apply the oil to the Spitzenburgs on account of the advanced foliage condition, Newtowns, whose development is more tardy, were substituted. The infestation here was about two thirds as severe as that existing in the arsenate of lead experiments.

All of the miscible oil applications proved to be decidedly efficient as agents in killing the leaf-roller eggs. In checking up the experiments it was found that the numbers of hatching eggs taken from the different plats varied directly with the strengths of oil used. These same variations, though of very narrow margins, were found to exist when the fruit counts were made.

In experiment 11, where 5 gallons to 100 were used, 92.1 per cent of the roller eggs failed to hatch. In the check rows (two rows left across the orchard on either side of which were two experimental plats), 96.8 per cent of the worms emerged. When the countings were made to determine the fruit injury it was found that the worms that escaped the oil caused a 3.6 per cent injury. On the check rows, 18 per cent of the apples were damaged by the worms. In increasing the oil to 6 gallons to the 100 in experiment 12, the efficiency increased from 92.1 per cent to 98.8 per cent. In this experiment, 2.9 per cent of the apples were injured by rollers or a very slight decrease from that noted in number 11.

TABLE II. OIL EMULSIONS

Exp. No.	Material Used	Strength	Date	Gals. per Tree	Results							
					Egg Count				Fruit Count			
					Eggs	Hatched	Killed	Per cent Killed	Fruits	Sound	Injured	Per cent Injured
7.	Kerosene Emulsion 1 tank	1 to 5.6	April 3	5	Exp. 7 1,217 CHECK 862	1,173 817	44 45 failed to hatch	3.6 5.	(Not efficient, no count)			
8.	Distillate Emulsion 1 tank	1 to 5.6	April 3	5	Exp. 8 937 CHECK 862	903 817	34 45 failed to hatch	3.6 5.	(Not efficient, no count)			
9.	Crude Oil Emulsion 1 tank	1 to 12	March 27	5.2	Exp. 9 827 CHECK 923	466 877	361 46 failed to hatch	43. 4.	1,064 CHECK 1,010	800 700	264 310	24. 30.
10.	Crude Oil Emulsion 1 tank	1 to 15	March 27	4	Exp. 10 1,014 CHECK 923	813 877	201 46 failed to hatch	19. 4.	1,091 CHECK 1,010	800 700	291 310	26. 30.
11.	Miscible Oil No. 1 (Balfour Guthrie Co.) 1 tank	5 to 100	April 3	5	Exp. 11 769 CHECK 960	61 929	708 31 failed to hatch	92.1 3.2	1,038 CHECK 1,045	1,000 850	38 195	3.6 18.
12.	Miscible Oil No. 1 (Balfour Guthrie Co.) 1 tank	6 to 100	April 3	5	Exp. 12 783 CHECK 960	9 929	774 31 failed to hatch	98.8 3.2	1,030 CHECK 1,045	1,000 850	30 195	2.9 18.
13.	Miscible Oil No. 1 (Balfour Guthrie Co.) 1 tank	7 to 100	April 3	5	Exp. 13 710 CHECK 960	5 929	705 31 failed to hatch	99.3 3.2	1,028 CHECK 1,045	1,000 850	28 195	2.7 18.
14.	Miscible Oil No. 1 (Balfour Guthrie Co.) 1 tank	8 to 100	April 3	5	Exp. 14 1,006 CHECK 960	4 929	1,002 31 failed to hatch	99.6 3.2	1,008 CHECK 1,045	1,000 850	8 195	.8 18.

In experiments 13 and 14 the results that were obtained seem to approach the incredulous. The high percentages attained in destroying the eggs is substantiated by the figures that were obtained in counting the fruit for roller injury. In number 13, 99.3 per cent of the eggs were killed and in number 14, out of 1,006 eggs examined, only four hatched. This give a killing percentage of 99.6 per cent. The fruit loss in this last experiment amounted to .8 per cent, eight injured apples being found in examining 1,000.

In summing up the experimental results it is found that efficiency is approached in experiment 5 where lead arsenate is used at the rate of 6 pounds to the 50 gallons of water and obtained in experiments 11 to 14 inclusive where miscible oil was used. In comparing the costs attached to using these materials, the miscible oil must be considered by far the more economical. The lead application costs for materials alone in the neighborhood of $1.65 per tank of 200 gallons. The miscible oil, as used in experiment 12, will cost about $1.50 per tank and, as it cannot be used in combination, the application will be extra. The marked increase in efficiency attained with the oil, however, more than warrants its use. For complete safety to the foliage, the oil applications should be made before the buds burst. Apparently no permanent injury occurred in our experimental plats this season from the late applications, but the margin of safety is extremely small and such a proceedure should not be generally followed.

The author wishes to thank Mr. F. W. Radford and Mr. Frank Davidson for their generous assistance and coöperation which has made possible the conducting of the large series of experiments during the past season.

VICE-PRESIDENT COOLEY: Mr. F. C. Bishopp will present the next paper.

A PRELIMINARY STATEMENT REGARDING WOOL MAGGOTS OF SHEEP IN THE UNITED STATES

By F. C. BISHOPP and E. W. LAAKE, *of the Bureau of Entomology*[1]

INTRODUCTORY

The wool maggots, although pests of importance to sheep raisers, have received practically no attention from investigators in the United States. In Europe, especially in the British Isles, the wool maggot is one of the most serious insect pests of sheep. In Scotland, in partic-

[1] Published by permission of the Chief of the Bureau of Entomology.

ular, every shepherd is familiar with this type of injury, and the watching of the flocks for infested animals and the destruction of the maggots are a part of their routine work. The common green-bottle fly, *Lucilia sericata*, is responsible for the trouble in Great Britain, and also in parts of continental Europe. Only those animals which have the wool considerably soiled with blood, fæces or urine are attacked. This species of fly is abundant in the United States, and, in fact, is almost world-wide in distribution.

The wool maggot assumes much greater importance in Australia than in any other part of the world. This, of course, is due to a considerable extent to the vastness of the sheep industry in that country. Professor W. W. Froggatt [1] states that during a single year the loss due to wool maggots in Australia was conservatively estimated at a million pounds. In that country eight species of flies are found to blow sheep, namely, *Calliphora villosa*, *C. oceaniæ*, *C. rufifaces*, *C. varipes*, *Lucilia sericata*, *L. cæsar*, *Ophyra nigra*, and *Sarcophaga aurifrons*. Professor Froggatt states that until about ten years ago only wounds of sheep were blown, but recently the flies appeared to have acquired the habit of attacking sheep of all classes upon the slightest provocation. In Hawaii another species of Calliphora (*C. dux*) has been reported by Van Dine [2] as causing serious injury to sheep by blowing the soiled wool.

Type of Injury and Species Concerned

In various parts of the United States the infestation of soiled wool on sheep is not uncommon, and in certain sections this is a problem of no little importance. Through the Central States the infestations usually occur in mid-summer and are confined largely to lambs or heavy wooled ewes which have the wool about the rumps soiled from diarrhea, or from being kept in dirty paddocks. A similar condition prevails in the Northwestern States, though infestations are infrequent as far as has been learned. The species of the fly or flies concerned in this injury has not been positively determined, although it is believed that the green-bottle flies, *Lucilia sericata* and *L. cæsar*, are responsible, at least in part.

In southwestern Texas, where the sheep industry is one of large extent, a somewhat different condition prevails. The most acute trouble occurs early in the spring, usually during April. The injury is of two types. First, the infestation of the wool about the rumps

[1] Froggatt, W. W., 1914. Sheep maggot flies in Australia. *Bulletin of Entomological Research*, Vol. 5, Pt. 1, pp. 37–39, April.

[2] Van Dine, D. L. and Norgaard, A. A, 1908. Abstract of a preliminary report on insects affecting live stock in Hawaii. Proc. Hawaiian Live Stock Breeders Assoc., pp. 19–70.

of ewes following lambing, and, second, the blowing of the wool about the base of the horns of rams. Owing to the fact that the sheep in this region receive no shelter during the winter and for the most part are dependent upon the range for food, lambing usually takes place during March and April. If lambing is undertaken earlier than this, the adverse weather conditions often cause considerable losses, and if extended beyond the first of May the screw-worm fly, *Chrysomyia macellaria*, is responsible for enormous losses among the ewes and newly dropped lambs. Showers which fall early in April are often followed by periods of warm, muggy weather and this condition is most favorable for fly attack. Practically all of the rams in western Texas have horns and their infestation is stimulated by slight wounds or bruises about the head which are often produced by fighting. In some cases dehorning is practiced, and, if the horns are not completely healed before the warm weather begins, infestation almost invariably follows.

The infestation of ewes is largely confined to the rump. Although the flocks are divided up considerably and each group is under the care of a herder, often the infestation proceeds for some time before it is noticed. At first the maggots confine their attack to the matted hair, usually working close to the skin. The inflammation produced soon results in the complete denudation of the portions attacked and the production of highly inflamed and practically raw areas. The maggots continue to spread into the adjacent wool from these centers and in many cases, if not destroyed, also penetrate the skin and soon cause the death of the sheep. In order to remove the infestation it is sometimes necessary to shear large areas in addition to the loss of wool caused by the larvæ themselves.

In the case of infested rams, the larvæ work for some little time immediately around the base of the horns. The condition produced extends the favorable breeding places, and in many cases the larvæ enter the ears and there produce additional complications. Infested sheep rapidly fall off in condition and soon refuse to eat. This reduces the milk supply of the ewes which sometimes results in the death of the lambs. It is stated by men who make a business of rearing rams that some years as high as one third of the rams in the state of Texas are lost on account of maggot and screw-worm infestations. The conditions produced by the wool maggots when infestations take place late in the spring frequently induce the attack of screw-worms.

Investigations conducted by the writers, during the spring of 1915, showed that the common black blow-fly, *Phormia regina*, was responsible for infestations in both of the above-mentioned places of attack. So far as the writers are aware, this is the first record of this species attacking soiled wool of sheep.

Some wool maggot infestations take place in western Texas during mid-summer and early fall, especially after the wool begins to get fairly long following the spring shearing. It is thought that *Lucilia sericata* is probably mostly concerned in these attacks although specimens have not been reared. Phormia is entirely absent or very scarce during mid-summer in Texas as will be discussed later, hence it could not be the culprit in this instance.

Seasonal History of *Phormia regina*

This species is widely distributed in the United States. It shows considerable differences in seasonal history in different sections of the country. In the Southern States the fly is active throughout the winter, although it may disappear for a few days during cold periods. It usually reaches its greatest abundance in the early spring, diminishing as hot weather comes on. During hot, dry seasons, in particular, the adults are not to be found in nature during June, July and August, although at Dallas, Texas, we have succeeded in keeping them breeding in cages throughout the summer. In the northern part of the country the fly is, of course, absent during the coldest weather, but is to be found in large numbers during the spring and fall, and in the extreme north is abundant throughout the summer. At Dallas, Texas, we have kept the species breeding throughout the winter, and it is not uncommon to find carcasses in nature which are literally swarming with maggots of this species during mid-winter. During the coolest weather the development is materially retarded, especially in the pupal stage. It is therefore most probable that in northern latitudes the insect passes the winter in the soil either in the pupal or pre-pupal condition.

Some rather interesting observations on the wintering of *P. regina* as compared with *Lucilia sericata* and other flies, including the screw-worm fly, *Chrysomyia macellaria*, were made on material collected on carcasses or butchers' offal in the autumn of 1914. One large lot of larvæ collected on offal on October 28, 1914, was fed on meat placed on sand at the laboratory in Dallas. Many were migrating during the nights of October 29 and 30 and many had pupated November 2. *P. regina* and *C. macellaria* began emerging November 14. Emergence in large numbers continued till the end of the month when adults of *C. macellaria* became few, *P. regina* continued to appear in good number till December 9, when emergence ceased entirely. On this date adults of *Lucilia sericata* began to appear, but all emergence stopped during the cold weather, until February 8, when *L. sericata* again began emerging and continued to appear more or less regularly up to April 15. The maximum emergence of *L. sericata* occurred about

the middle of March. Five specimens of *Sarcophaga* sp. emerged, these appeared on March 30, April 2, 10, 13 and 15.

Other large supplies of larvæ and pupæ collected in the fall showed very similar results as regards emergence; the adults of *P. regina* emerge when the temperatures are moderate in fall and spring but the Lucilias do not appear till later in the spring.

The seasonal occurrence of infestations of *P. regina* in Texas appears to range from the beginning of lambing, which is about December 1, to shearing time. Shearing is begun in April and extends to June, the ewes being the last to be shorn. The cessation of injury in early summer is due to the dimunition of the number of Phormia and more especially to the abolition of favorable places for attack by the removal of the wool.

Life-History and Habits of *Phormia regina*

So far as we have observed, *Phormia regina* breeds exclusively in animal matter or in substances in which animal matter is intermixed. The species is found very generally distributed where it normally occurs. Specimens have been observed far from any habitation, and it is also very commonly met with in the center of large cities. While the flies visit freshly killed animals and fresh blood, they show a special predilection for meat which is in a decaying condition and consequently having a strong odor. It is probably the odor of the soiled wool, especially when some blood is present, which attracts the flies to the living sheep. This species has been observed to breed in large numbers in the paunch contents of cattle which has been more or less saturated with blood during slaughtering. They do not deposit eggs in this material if no blood is present.

Under range conditions it has been found that carcasses of large domestic animals are responsible for the vast majority of flies present. During the fall, winter and early spring probably nine-tenths of the flies which breed in carcasses are of this species. Small wild animals and birds also supply favorable breeding places.

The adults feed freely on various substances but are especially attracted to juices from animal matter. They are rarely observed on fecal matter if no blood or animal tissue is present. Human fæces and excrement of hogs are much more frequently visited than droppings of herbiverous animals.

In cages ranging up to 10 x 10 x 6 feet, flies were found to require from six to eighteen days after emergence before oviposition began. The adults show a marked tendency to deposit their eggs in large masses. This tendency is more noticeable than in other meat-infesting species. Hatching takes place in less than twenty-four hours up

to about four days. Eggs deposited on living animals probably hatch in eight or fourteen hours. The larvæ complete their growth in from four to seventy-six days, and shortly before pupation show a marked tendency to migrate from the material upon which they have been feeding. They usually enter the ground, sometimes to a depth of three or four inches, but some pupæ may be found under loose objects lying on the surface of the soil. The pupal stage ranges from three days to over a month. The larvæ and pupal periods are shortened somewhat as the mean daily temperature increases but excessively hot weather is detrimental to breeding, apparently, however, affecting the adults even more than the immature stages.

The total developmental period ranges from nine to at least seventy-six days.[1] Dr. E. P. Felt,[2] working at Nassau, N. Y., records the duration of stages in this species as follows: Egg stage, 8 to 24 hours; 1st larval stage, about 3 days; 2d larval stage, 2 to 3 days; 3d larval stage, active feeding period, 3 days; period from entrance into soil to first adult emergence, 14 days. Thus about twenty-three days were required for the cycle from egg to adult. The accompanying table includes some of our data on developmental periods.

TABLE I. DEVELOPMENTAL PERIODS OF *Phormia regina* AT DALLAS, TEXAS

Date Eggs Deposited	Date Hatched	Incubation Period	Dates of Pupation		Larval Period	Dates adults emerged		Pupal Period	Total Developmental Period
			First	Last		First	Last		
1914		Days			Days			Days	Days
Apr. 11, 3 p.m.	Apr. 15, 10 a.m.	3¾	Apr. 24	Apr. 29	9 to 14	May 2	May 5	8 to 11	21 to 24
Apr. 14	Apr. 15, p.m. or Apr.16,a.m.	1 or 2	Apr. 25		9 or 10	May 4	May 5	9 to 10	20 to 21
May 24–25	May 26	1 to 2	May 31	June 3	5 to 8	June 6	June 8	6 to 8	12 to 15
May 18	May 19	1	May 27	May 29	8 to 10	June 3	June 5	7 to 9	16 to 18
May 27	May 28	1	June 1	June 3	4 to 6	June 8	June 10	7 to 9	12 to 14
June 19	June 20	1	July 24		4	July 28		4	9
June 8	June 9	1	June 13	June 16	4 to 7	June 19	June 20	6 to 7	11 to 12
Sept. 19	Sept. 20	1–	Sept. 28	Sept. 29	8 to 9	Oct. 5	Oct. 8 1915	7 to 8	16 to 19
Oct. 22	Oct. 23	1+	Nov. 11 1915	Nov. 20 1915	19 to 28	Dec. 4 1915	Jan. 6	23 to 56	43 to 76
1913	Dec. 19[1] 1915		Feb. 12	Mar. 5	55+ to 76+	Mar 5 to 29		21 to 45	76+ to 90+
May 18	May 19	1+	May 25	May 27	6 to 8	May 31	June 1	6 to 7	13 to 14

[1] Larvæ from one-half to full grown collected on date.

[1] The developmental periods of *P. regina*, *Lucilia sericata* and *L. cæsar* as compared with several other meat-breeding flies are summarized by one of the authors (Bishopp) in the JOURNAL OF ECONOMIC ENTOMOLOGY, VIII, pp. 325–329, 1915.

[2] Felt, E. P., 1913. Bull. 165, N. Y. State Museum, pp. 75–79, pls. 3–6.

When caged without food the longevity of the adults is rather short, ranging from two to eight days. Supplied with suitable food and meat upon which to deposit they have been observed to live as long as ninety-three days in winter and thirty-one days in April and May. The longevity decreases as hot weather approaches.

Seasonal History of *Lucilia sericata*

This species is to be seen through the year in the Southern States except in the coldest periods in winter. It is not so plentiful, however, in late fall, early spring and in warm periods in mid winter as is *P. regina*. Reproduction does not often take place in winter even in the extreme South. The adults are present throughout the summer though then often diminish in numbers during excessively hot dry periods. In Texas the winter is passed in the larval and pupal stages in the soil or beneath carcasses. It is almost certain that in the North, also, the same condition prevails. Attempts to get the adults to pass the winter in cages have been unsuccessful. Some information regarding wintering is given under the discussion of the seasonal history of *P. regina*.

Life-History and Habits of *Lucilia sericata*

This species has a wide distribution in North America. It is more closely associated with human habitations than *P. regina* or *C. macellaria*, being very common in back yards and in alleys even in large cities. It is seldom seen on the range and in pastures far from houses. Garbage, including all sorts of kitchen refuse, is attractive, and damaged fruit is a favorite food for the adults. The flies are not infrequently seen in dwellings and often collect in great numbers under ornamental vines and beneath the leaves of vegetables, especially cucumbers and melons. They visit flowers to some extent and are strongly attracted to honey-dew on plants.

We have not succeeded in securing depositions or rearing larvæ on other substances than animal matter. Eggs are freely deposited on raw or cooked meats in various stages of decay and on carcasses of all kinds. As has been stated, this is the species responsible for maggoty wool in Great Britain and doubtless is the principal cause of cases of blown sheep which occur in mid-summer in this country. Mr. H. F. Hudson[1] has recently reported an instance in Ontario in which a calf suffering from white scours became infested around the vent by this green-bottle fly. Two cases have been observed by the senior author in which tame rabbits, having injuries on their backs from fighting, became infested and were ultimately killed by maggots of this species.

[1] Hudson, H. F., 1914. *Canadian Entomologist* 46, p. 416, December.

The longevity of the adults when kept without food is very short, from one to three days. When supplied with suitable food, we have observed a longevity of ten to forty days. The period from emergence of the adults to the beginning of egg-laying ranges from four to twenty-one days. Incubation varies much with the temperature, usually slightly less than twenty-four hours are required, but somewhat shorter periods have been observed, and the maximum incubation period which we have noted is seven days. The developmental periods are shown in the accompanying table.

TABLE II. DEVELOPMENTAL PERIODS OF *Lucilia sericata* AT DALLAS, TEXAS

Date Eggs Deposited	Date Hatched	Incubation Period	Dates of Pupation		Larval Period	Dates Adults Emerged		Pupal Period	Total Developmental Period
			First	Last		First	Last		
1913	1913	Days	1913	1913	Days	1913		Days	Days
July 28	July 29	1–	Aug. 3		5	Aug. 8		5	11
Aug. 16	Aug. 17	1–	Aug. 26		9	Aug. 31		5	15
1914	1914		1914	1914		1914	1914		
Sept. 4	Sept. 5	1–	Sept. 9	Sept. 10	4 to 5	Sept. 14	Sept. 17	5 to 8	10 to 14
				1915			1915		
Oct. 21	Oct. 22	1	Nov. 5	Mar 15	14 to 144	Dec. 21	Apr. 18	46 to 164	61 to 179
						1915			
Oct. 22	Oct. 23	1+	Nov. 11	Apr. 5	19 to 164	Apr. 10	Apr. 22	150 to 162	170 to 182
						1914			
Oct. 24	Oct 25	1+	Nov. 11	Apr 5	17 to 162	Dec. 5	Apr. 22	24 to 162	42 to 180
			Before	After		1915			
Oct. 29	Oct 30	1+	Feb. 11	Mar 5	104– to 126+	Apr. 6	Apr. 19	54 + to 67	159 to 172
				After					
Nov. 1	Nov. 2	1+	Nov. 17?	Mar. 5	15 to 123	Mar. 17	Apr. 15	121? to 149?	137 to 166
1915	1915		1915						
Apr. 24	Apr. 25	1+	Apr. 30	May 3	5 to 8	May 10	May 20	10 to 20	16 to 26
Apr. 25	Apr. 26	1+	May 1	May 6	5 to 10	May 14	May 17	13 to 16	19 to 22
Apr. 26	Apr. 27	1+	May 2	May 14	5 to 17	May 13	May 20	11 to 18	17 to 24
Apr. 27	Apr. 28	1–	May 5	May 14	7 to 16	May 15	June 5	10 to 31	18 to 39

SUGGESTIONS REGARDING CONTROL

In this preliminary paper it is not desired to discuss at length various means of repression which may be of value, but a few of the principal points will be touched upon. In order to mitigate the injury due to these species it is essential that greater care be exercised in destroying carcasses of animals. These should be burned as soon as possible after death. In case of shortage of fuel it is sometimes more feasible to bury carcasses, especially of small animals. Preliminary experiments with the burial of carcasses indicate that under most conditions it is necessary to cover an infested animal with two feet of earth in order to prevent the flies from emerging. If an animal is buried before infestation takes place, a few inches will suffice to protect it from infestation.

The treatment of carcasses with borax and certain other chemicals has given fair results but is not as satisfactory as burning.

To prevent infestation of sheep following lambing it is desirable that lambing be done during the winter whenever practicable. In some cases this will necessitate changes in range practices, including the feeding of ewes and furnishing shelter for them. Where lambing is done during weather which is conducive to fly breeding, it is important that the flocks be divided into fairly small units and carefully watched. In exceptionally bad seasons, the systematic trimming of the soiled wool from between the legs and around the vent of the ewes is a good preventive. An effort should be made to keep the sheep in strong, healthy condition and avoid scouring. No doubt dipping the rumps of sheep in repellant solutions will also prove beneficial although some damage to the wool would usually result. Investigations along this line have not been completed.

It is very desirable that strains of hornless sheep be developed for use throughout the United States, especially in regions where wool maggots and screw-worms occur in numbers.

In treating infested sheep it is important to trim the wool away so as to allow the insecticide used to thoroughly reach the maggots, and to lessen the danger of reinfestation. The trimming should be begun around the outside of the infested area so as not to drive the maggots back into the clean wool. Concoctions containing a considerable percentage of chloroform have been found effective in destroying the maggots. It is advisable to add a small quantity of oil of tar to the material used to act as a repellant for the flies.

A hymenopterous parasite, presumably *Nasonia brevicornis* Ashmead, has been found to breed freely in the puparia of a number of carrion infesting flies, including *P. regina* and the two species of Lucilia. As many as thirty-five parasites have been observed to develop within one puparium. Ten puparia of a species of Sarcophaga exposed to parasitism produced 343 adult parasites. The developmental period at Dallas as observed by the junior author ranges from nineteen days upwards. Considering the comparatively short period required for development and the reproductive capacity of an individual parasite, this species is to be looked upon as an important natural check to fly-breeding. Often where the puparia are concentrated, as around a carcass, a high percentage of parasitism results. Other parasites have been reared but this one is most important.

VICE-PRESIDENT COOLEY: The next paper will be presented by Mr. E. D. Ball.

FIELD NOTES ON GRASSHOPPER OUTBREAKS

By E. D. Ball, *Logan, Utah*

(Withdrawn for publication elsewhere.)

Adjourned 4.30 p. m.

Morning Session, August 10, 1915

The session was called to order at 10.15 a. m. by Vice-President Cooley.

Vice-President Cooley: The first paper will be read by Mr. C. E. Pemberton.

THE EFFECT OF COLD STORAGE TEMPERATURES UPON THE EGGS AND LARVÆ OF THE MEDITERRANEAN FRUIT FLY

By E. A. Back and C. E. Pemberton, *Honolulu, T. H.*

(Withdrawn for publication elsewhere.)

Vice-President Cooley: The next paper is by Mr. A. L. Melander.

VARYING SUSCEPTIBILITY OF THE SAN JOSÉ SCALE TO SPRAYS[1]

By A. L. Melander, *Pullman, Wash.*

There seems to be no doubt but that sulphur-lime has ordinarily been a most efficient scalecide. In the arid region at Wawawai, Washington, Piper twelve years ago was able to announce complete destruction of the San José scale in one to two weeks after the application. Similar quick results have been observed in recent years with scales from Wenatchee. On the other hand, this insect is becoming increasingly prevalent in some of the older fruit sections of Washington, notably at Clarkston, and a critical investigation shows that not only are the scales slow to succumb to the effects of sulphur-lime but that there is a pronounced and great individual difference, many scales manifesting even a complete immunity to this insecticide.

[1] Contribution from the Zoölogical Laboratory of the State College of Washington.

After witnessing encrusted scale insects surviving a bath ten times normal strength, or others still alive and growing after three biweekly sprayings of a stronger than usual sulphur-lime, one cannot agree with the statement that the prevalence of the insect is due to faulty application. It must be due in part at least in these cases to an inherent vigor of the insect to withstand the toxic effects of the spray. To determine the range of individual susceptibility to this and other sprays and to ascertain the proportion of immune individuals, and thus to measure the biological difference in scales from several localities, the Washington Experiment Station some years ago instituted a series of experiments in which identical solutions were sprayed at selected places. The results of the tests of 1913 were reported at the Atlanta meeting of the Association of Economic Entomologists and were published in the JOURNAL OF ECONOMIC ENTOMOLOGY for April, 1914.

It is the purpose of this paper to announce the results obtained this year, which, while corroborating the previous seasons' tests, show even a greater range in susceptibility among the scales from various localities.

The plan of the experiment took as a standard three-degree factory-made sulphur-lime, comparing this with both stronger and weaker sprays and checking against oil emulsions as well as against no spraying at all. The sulphur-lime concentrate tested thirty-four degrees Beaumé and was made at the Petrie plant at Clarkston. This was diluted for tests at five degrees, three degrees and two degrees. Thomson's Orchard Brand oil emulsion at 5 per cent strength was used as in the tests of the two preceding years. Owing to difficulty in emulsifying crude oil with the liquid soap at hand the results with this insecticide were not promising and will be neglected in the present discussion. A sulphur-soda spray known as Soluble Sulphur also was used at each place made up in concentrations equivalent to the sulphur-limes used. For comparison with the tests made in preceding years the spraying was done at Clarkston, Walla Walla, Sunnyside, North Yakima and Wenatchee, although different trees were used at all the places except Sunnyside. Apples were used throughout the experiments.

The applications were given just previous to the swelling of the buds, a narrow cylinder bucket pump and Bordeaux nozzle being employed. The selected branches were more than drenched with a driving spray so as to avoid the possibility of missing any individuals. Whenever there was any danger of the spray drifting to other selected branches the parts being treated were isolated by large cloth sheets previously rendered water-proof by immersion in a gasoline solution of mutton tallow.

At intervals of two or three weeks, sample branches were pruned from each test and the condition of the sprayed scales was noted by dissection under the prism binocular microscope. The numbers of living and dead scales were recorded by means of a pair of tally registers operated by the examiner's feet. Here, naturally, enters the personal element in forming a decision in the case of dying or just dead scales. Practically all the counts were made by A. L. Melander and M. A. Yothers checking against each other from different samples of each test, and in the following tabulations the percentages given are the average of their two counts. Not only is it extremely difficult, if not impossible, to decide just when a scale insect dies, but the last counts were further vitiated by certain scales dropping from the branches. This seemed to be particularly true where the stronger sulphur sprays were used, and forms a factor that should not be neglected when discussing the insecticidal properties of these sprays. It seems that a polysulphide spray changes the waxy covering so as to render it difficult for the awakening scale to attach its spring secretions. Thus in some instances the body of the insect grows beyond the scale-covering, loosening and raising it from the plant epidermis so that ultimately it falls off. Such unprotected individuals perish and drop from the branches. While this mode of death is more or less of a factor in sulphur-lime treatment, yet it is not of great importance unless the spray is used unduly strong.

Sulphur-lime is supposed to kill principally by chemical suffocation, due to its strong affinity for oxygen. During the reaction the protoplasm of the insect changes in appearance, becoming viscous and in color luteous yellow until further change darkens the protoplasm to a brown and changes its consistency to an oily meal. Just when the transition point occurs where this reaction ceases to be reversible and death ensues is unknown, but in interpreting results the insect at the viscous, luteous stage is considered dead. During warm weather the moisture of the protoplasm quickly disappears as soon as the insect dies, and hence when scales die from the first shock of deoxygenation, their dead condition can be interpreted within a few days or weeks. Furthermore, in making these counts, only the small blackish overwintering scale insects are considered, since overwintering adults are of extremely rare occurrence. After the males had emerged, their empty shells were rated as living insects in order not to disturb the balance of the sexes at the last count. Whatever element of uncertainty might appear in making determinations of doubtful cases is largely offset by the large numbers counted, for during the season over 170,000 scales were individually dissected from the branches and their condition recorded.

Wenatchee

In previous years sprays used at Wenatchee have shown their final value within two weeks' time. This year the first counts, twenty days after the application, showed about 40 per cent of the individuals still in living condition whenever sulphur sprays were used. Oil prayed insects after the same interval were completely killed. The second count, however, thirty-seven days after spraying, uniformly showed practical extermination, only 1 to 3 per cent of the scales being rated as alive. This was also the condition recorded at the final count, twenty-four days later. The following tabulation briefly gives the proportion of living insects at the successive counts:

	20 days	17 days	24 days
Sulphur-lime, 5°	45%	2.3%	1.4%
Sulphur-lime, 3°	34	0.8	1.6
Sulphur-lime, 2°	48	3.	2.2
Sulphur-soda, 2°	50	1.1	1.8
Oil, 5%	0	0	0
Check	53	67	45

North Yakima

Tests of 1914 carried on by M. A. Yothers indicated that the San José scale at North Yakima died about as slowly from the effects of sulphur-lime spraying as at any of the other places of the circuit. This year the first counts, twenty-one days after the application, showed about 50 per cent of the insects still alive. The second count hovered around 20 per cent, and the third around 10 per cent. The several proprietary oil sprays used gave much more rapid and effective results, practically exterminating the insects by the twentieth day.

	21 days	19 days	12 days	30 days
Sulphur-lime, 5°	36%	19%	4%	10%
Sulphur-lime, 3°	49	17	2	3
Sulphur-lime, 2°	35	31	3	.8
Sulphur-soda, 3°	45	26	9	25
Sulphur-soda, 2°	58	24	8	24
Oil, 5%	1	1	0.2	0
Check	88	83	67	74

There is some uncertainty as to the best time to apply sulphur-lime. The general custom in Washington does not call for fall spraying, but formerly applications in early February or late January were in vogue. The tendency is to postpone this spraying, possibly due to the influence of the introduced budmoth and twig-borer which require later spraying, until now the winter application is not begun

until the middle of March and is continued into April, in some instances deferred even until the trees are coming into leaf. Accordingly, in order to obtain critical evidence bearing on this problem certain treatments were repeated on March 26, nineteen days after the original tests were given. While the information they afford is not conclusive, these tests indicate that later sprayings are much less dependable than the earlier. The insects die in both cases at about the same rate during the weeks immediately following the spraying, but when growth sets in there is a larger proportion of survivors in the case of late spraying and these individuals, no longer subject to the action of the weathered spray, are able to negative the effects of the spraying. The following tabulation shows what a large proportion of scales are able to withstand a late application at North Yakima:

	21 days	12 days	29 days
Sulphur-lime, 3°	28%	22%	26%
Sulphur-lime, 2°	29	47	49
Sulphur-soda, 3°	41	38	48
Sulphur-soda, 2°	44	43	43

Walla Walla

Sulphur-lime has been used at Walla Walla probably as long as anywhere in the northwest and if its influence is selective, hardy scales should be expected to occur here. The tests with the same materials that were used at the other stations gave uniformly poor results in the case of sulphur sprays but the oil spray again afforded complete and rapid extermination. It should be noted that by the time of the final examination the male insects had long since emerged and the females were gravid with young.

	20 days	15 days	20 days
Sulphur-lime, 5°	49%	35%	34%
Sulphur-lime, 3°	48	28	27
Sulphur-lime, 2°	57	37	27
Sulphur-soda, 3°	36	28	32
Sulphur-soda, 2°	53	42	36
Oil, 5%	1	0	0
Check	92	89	72

Clarkston

Clarkston at the present time is probably as badly over-ridden with San José scale as any fruit district. The destruction wrought by this insect is almost inconceivable: cherry and peach trees are dying throughout the lower part of the flat and the apple and pear crop is so badly specked with scale as to be unmarketable. Conditions in the adjacent district, Vineland, higher in elevation, are not nearly

so bad, however, While part of the infestation, here as elsewhere, is unquestionably due to faulty application, inefficient methods cannot be blamed for everything. The spraying tests below recorded were carried out thoroughly. The weather was ideal and the insects were drenched with liquid. Nevertheless none of the sulphur sprays afforded anything like satisfactory control and this year even the Orchard Brand of oil failed to give its usual complete success. Unquestionably under conditions like this, sulphur-lime as well as other sulphur sprays should be abandoned in favor of other materials having different insecticidal properties.

	20 days	15 days	15 days	20 days
Sulphur-lime, 10°	65%	41%	28%	43%
Sulphur-lime, 5°	35	41	39	45
Sulphur-lime, 3°	92	59	45	45
Sulphur-lime, 2°	69	63	61	32
Sulphur-soda, 3°	86	51	67	29
Sulphur-soda, 2°	97	72	67	46
Oil, 5%	7	5	3	3
Check	89	98	94	55

This investigation has shown that differences in results from spraying are due to locality rather than to the strength of the solutions used. There is a much greater variation in the effectiveness of the three degree sulphur-lime comparing Wenatchee and Clarkston than there is when comparing a two-degree with a ten-degree sulphur-lime used at Clarkston alone. This contrasting difference between Wenatchee and Clarkston cannot wholly be ascribed to climate, nor to the condition of the trees, nor to the water used in diluting the sprays, nor to comparative thoroughness of application, nor apparently to any combination of extrinsic factors. The prevalence of scale at Clarkston and its scarcity at Wenatchee where effective spraying has kept it in complete control, further bear out the supposition that there is an inherent biological difference in the insects of the two places.

VICE-PRESIDENT COOLEY: Could you find no other cause than heredity for the resistance to treatment?

MR. A. L. MELANDER: That is the only cause that has been determined thus far.

MR. S. W. FOSTER: In comparing treatment on different trees, the weather conditions should be similar at the time parallel tests are made. A variation of a week's time in doing part of the spraying might give quite different results.

MR. A. L. MELANDER: In the tests mentioned the weather conditions were as near similar as possible.

MR. F. C. BISHOPP: Was there a record of the previous treatment that had been applied to the orchards mentioned?

MR. A. L. MELANDER: We have a record for ten years in the orchard at Charleston, where 5 per cent to 10 per cent survived treatment. In some cases we got as good results with a weak as with a heavy spray. In some cases from 20 per cent to 50 per cent of the insects survived treatment.

VICE-PRESIDENT COOLEY: The next paper will be read by Mr. H. F. Wilson.

THE TOXIC VALUES OF THE ARSENATES OF LEAD

By H. V. TARTAR, *Chemist*, and H. F. WILSON, *Entomologist, Oregon Agricultural College Experiment Station*

For several years investigations have been carried on at the Oregon Agricultural Experiment Station to determine the relative insecticidal values of the different insecticides in common use. The problems taken up have involved both chemical and entomological work and the data obtained show some very interesting results. Among other things the work done has shown that there are two different arsenates of lead present in the commercial material and that they are quite variable in their action and efficiency. We designate these compounds as lead hydrogen arsenate (acid) and basic lead arsenate (neutral) and experiments made, using both substances in a pure state, show that the first is quicker acting than the second and apparently more efficient in strengths containing equal amounts of arsenic. The data presented in this paper deal with experiments conducted to determine the comparative toxic value of these compounds.

Considerable difficulty was experienced in securing a satisfactory agent for the determination of these toxic values. Very few insects were found to occur in desirable numbers and all of them are present only for a more or less limited period. Of these the common tent caterpillar, *Malacosoma pluvialis* Stretch, was found to offer the best means. This species occurs gregariously in colonies of a hundred or more individuals and during the months of April, May and June large numbers of the larvæ are available. They also feed on all kinds of foliage and eat greedily so that the poison is easily fed to them.

The general plan of the work was to cover the leaves of the twigs with the arsenates in different strengths; then, by the use of some insect which would feed on the foliage, to determine the comparative killing properties and finally to determine by chemical analysis the exact quantity of arsenic consumed.

The Experiments

An effort was made to use a certain set number of larvæ for each experiment but this was found to be unsatisfactory as the individuals clung to the nests and were frequently injured in handling. The next best method was to remove all the foliage from one or more tents and then to fasten the tents to the twigs. In a short time the caterpillars migrated to the leaves and began feeding.

Two sets of experiments were carried on to secure an even coating of the poison on the leaves. In the first set the poison was weighed out and placed in an aquarium jar with the water. This mixture was thoroughly agitated and two small apple twigs were then immersed in the suspension and placed in bottles of water to prevent wilting. In the second set the poison was applied as a spray by means of an ordinary glass hand-sprayer. No difference could be noted in the apparent amount of poison present on the leaves by either of these means of application. As soon as the foliage became dry the caterpillars were placed on the twigs.

Each morning following, the dead larvæ, measuring near an inch in length, were gathered, counted, and placed in glass bottles. At the conclusion of the experiments these samples were analyzed for arsenic content.

The following strengths were used:

Series I

2 to 50 gallons of water (L.H.A. and B.L.A.[1])	10.3	grams to 2000 cc. H_2O
2 to 100 gallons of water (L.H.A. and B.L.A.)	5.18	grams to 2000 cc. H_2O
2 to 200 gallons of water (L.H.A. and B.L.A.)	2.59	grams to 2000 cc. H_2O
2 to 400 gallons of water (L.H.A. and B.L.A.)	1.295	grams to 2000 cc. H_2O
2 to 800 gallons of water (L.H.A. and B.L.A.)	.6475	grams to 2000 cc. H_2O

The first three sets were applied April 22, the other two April 23, 1915.

Series II

2 to 50 gallons of water (L.H.A. and B.L.A.)	2.59	grams to 50 cc. H_2O
2 to 100 gallons of water (L.H.A. and B.L.A.)	1.281	grams to 50 cc. H_2O
2 to 200 gallons of water (L.H.A. and B.L.A.)	.647	grams to 50 cc. H_2O
2 to 400 gallons of water (L.H.A. and B.L.A.)	.3237	grams to 50 cc. H_2O
2 to 800 gallons of water (L.H.A. and B.L.A.)	.1618	grams to 50 cc. H_2O
2 to 1200 gallons of water (L.H.A. and B.L.A.)	.1067	grams to 50 cc. H_2O

The first series was applied May 5; the other five May 4.

The larvæ were gathered each day from paper placed under the vessels containing the twig. The data obtained are tabulated as follows:

[1] L.H.A. = Lead Hydrogen Arsenate; B.L.A. = Basic Lead Arsenate. The former contains approximately 33 per cent arsenic oxide, the latter 25 per cent.

SERIES I

No.	Strength and Kind of Spray	Applied	Drop						Total Drop
			April 24	April 25	April 26	April 27	April 28	April 29	
1	2:50 L.H.A.	Apr. 22, 1915	325	46	30	20	24	..	445
	2:50 B.L.A.	Apr. 22, 1915	12	17	98	48	30	..	205
2	2:100 L.H.A.	Apr. 22, 1915	56	101	94	51	39	..	341
	2:100 B.L.A.	Apr. 22, 1915	..	7	23	82	57	33	202
3	2:200 L.H.A.	Apr. 22, 1915	46	60	103	121	33	9	371
	2:200 B.L.A.	Apr. 22, 1915	..	5	6	40	101	68	220
4	2:400 L.H.A.	Apr. 23, 1915	..	..	88	57	104	83	332
	2:400 B.L.A.	Apr. 23, 1915	..	..	14	42	57	88	201
5	2:800 L.H.A.	Apr. 23, 1915	..	..	43	110	177	88	418
	2:800 B.L.A.	Apr. 23, 1915	..	..	3	43	108	137	291

SERIES II

No.	Sprays	Date Applied	May 5	May 6	May 7	May 8	May 9	May 10	May 11	May 12	May 13	Summary Total
1	AL 2:50 L.H.A.	May 5		21	103	83	69	36	33	5	2	352
	AL 2:50 B.L.A.	May 5		3	128	169	53	201	126	66	38 (all dead)	784
2	AL 2:100 L.H.A.	May 4	9	45	69	95	3	19	...	..	..	240
	AL 2:100 B.L.A.	May 4	..	6	17	108	19	41	...	..	..	191
3	AL 2:200 L.H.A.	May 4	65	123	209	118	31	107	...	..	..	653
	AL 2:200 B.L.A.	May 4	..	12	77	139	34	75	46	20	..	453
4	AL 2:400 L.H.A.	May 4	19	77	154	192	44	85	33	..	..	604
	AL 2:400 B.L.A.	.....	..	5	21	87	65	42	34	30 (20 more or less alive)	..	284
5	AL 2:800 L.H.A.	.....	5	61	106	175	50	97	30	35 (several alive)		568
	[1]AL 2:800 B.L.A.	.....	..	3	12	49	21	36	25	6	...	152
6	AL 2:1200 L.H.A.	.....	..	12	36	163	115	77	42	93 (picked off)	(a few alive) 23	561
	AL 2:1200	.....	..	..	7	23	44	39	46	42 (picked off)	22	223 (at least 25 feeding on first foliage)

[1] Where strengths of 1 to 1200 were used it was necessary to add a second set of sprayed twigs as caterpillars ate all foliage on first set.

Observations

Notes taken during the course of the experiments show very clearly and conclusively that the lead hydrogen arsenate is quicker acting than the basic salt and that smaller amounts are required for killing efficiency. Also, that although the caterpillars on the experiments sprayed with the basic form lived longer, they finally died, and with strengths where less than 2 lbs. to 200 gallons was used the damage done before they died was not serious. These experiments further show that the killing efficiency is reduced in proportion to the reduction of the amount of material used, and that beyond certain strengths they lose their destructive value because the caterpillars cause very serious damage before the quantity of poison eaten is large enough to kill.

A comparison of the efficiency values shows that the lead hydrogen arsenate in strengths of 2 to 50 was quicker acting than the basic, but the results obtained with the latter were satisfactory in that practically the same amount of foliage was eaten in both cases. In strengths of 2 to 100 the difference in action was greatly in favor of the lead hydrogen arsenate but only a slight difference was noticed in the amount of foliage destroyed.

In strengths of 2 to 200 similar conditions were noticed, but with the basic lead arsenate the amount of foliage destroyed was increased. In strengths of 2 to 400 both materials acted more slowly and a considerable part of the foliage was eaten on the basic lead arsenate experiment. The lead hydrogen still remained satisfactory.

In strengths of 2 to 800 practically the same conditions existed, the poison acted slower and the amount of foliage eaten increased.

In strengths of 2 to 1200 neither form prevented serious damage and with the basic form the first twigs were completely defoliated and a second set partly destroyed. As shown in the table these experiments were discontinued before all the caterpillars died because it was not thought necessary to carry them further.

Further comparisons showed that the lead hydrogen arsenate 2 to 200 was more efficient than the basic 2 to 100 and that the lead hydrogen arsenate 2 to 400 was more efficient than the basic 2 to 200 in the protection of foliage.

In the tables it will be noted that as a rule only a few died the first day or two, the heaviest drop occurring within two or three days. This may be accounted for in several ways.

A few caterpillars begin feeding immediately upon being transferred. These are usually quite hungry and eat considerably before stopping. The others feed later at a time more or less regular to their habits and eat according to their hunger, some eating rapidly and devouring considerable foliage before the poison can act. Others eat only a small amount or eat slower and although they become sick they manage to survive for a longer period in proportion to the amount eaten. The behavior of the poisoned caterpillars is practically the same in all cases but varies considerably with the amount eaten. Usually those that are slightly sick wander around to a more or less extent but do not feed and if possible they will leave the twigs. Those with larger doses cluster together and gradually become sluggish, being at first sufficiently active to move the head and forepart of the body from side to side when disturbed. Later they barely move and finally may drop off or remain suspended from the tent by the prolegs.

Chemical Analyses

The chemical analysis of the poisoned caterpillars from each of the tests was made by first drying at 100 degrees centigrade to get the actual weight of the dry tissue of the insects. Then the arsenic was determined in the following manner: A quantity of the dried tissue, not exceeding 4 grams, was introduced in a Kjeldahl flask, 500 cc. capacity, and about 15 cc. of arsenic free concentrated sulfuric acid added. The flask was then placed over a medium flame and heated until fumes of sulfur dioxide were given off. Fuming nitric acid (arsenic free) was next added in small quantities (2 cc.) at short intervals until all the organic matter was oxidized and the solution was perfectly clear. The solution was then digested over a hot flame for two hours. Following the digestion the excess of sulfuric acid was carefully driven off and the arsenic determined by titration with fiftieth-normal iodine solution after reduction with potassium iodide, according to the modified Gooch and Browning method (Bul. 107 Revised, Bureau of Chemistry, U. S. Dept. of Agr., p. 239). The results were calculated in terms of milligrams of arsenic oxide, As_2O_5.

The data obtained from the analytical work are given in the following tables.

For convenience in making comparisons, the milligrams of arsenic oxide in 1 gram of dried tissue have been estimated in each instance.

EXPERIMENT No. 1

No.	Spray	No. of Caterpillars	Weight of Dry Tissue (Grams)	Milligrams of Arsenic Oxide (As_2O_3)	Milligrams of Arsenic Oxide (As_2O_3) to 1 gram of Dry Tissue.
1	2:50 L.H.A.	445	3.973	2.96	0.74
2	2:50 B.L.A.	205	1.423	0.86	0.60
3	2:100 L.H.A.	341	1.262	0.86	0.68
4	2:100 B.L.A.	202	1.623	0.48	0.30
5	2:200 L.H.A.	371	1.751	0.40	0.23
6	2:200 B.L.A.	220	1.056	Trace[1]	
7	2:400 L.H.A.	332	1.674	0.34	0.20
8	2:400 B.L.A.	201	.831	Trace	
9	2:800 L.H.A.	418	1.337	0.08	0.06
10	2:800 B.L.A.	291	2.035	0.28	0.14

[1] One drop fiftieth normal iodine for titration.

EXPERIMENT No. 2

No.	Spray	No. of Caterpillars	Weight of Dry Tissue (Grams)	Milligrams of Arsenic Oxide (As_2O_3)	Milligrams of Arsenic Oxide (As_2O_3) to 1 Gram of Dry Tissue.
1	2:50 L.H.A.	176	3.383	2.30	0.62
2	2:50 B.L.A.	261	3.520	1.72	0.49
3	2:100 L.H.A.	240	4.046	1.86	0.46
4	2:100 B.L.A.	191	3.150	1.50	0.47
5	2:200 L.H.A.	185	2.990	0.72	0.24
6	2:200 B.L.A.	453	4.835	1.29	0.26
7	2:400 L.H.A.	302	3.790	0.86	0.23
8	2:400 B.L.A.	284	3.222	0.57	0.18
9	2:800 L.H.A.	284	3.719	0.43	0.11
10	2:800 B.L.A.	152	2.303	0.15	0.06
11	2:1200 L.H.A.	280	3.582	0.28	0.08
12	2:1200 B.L.A.	223	2.354	0.15	0.06

These results show that in most cases the arsenic content of the caterpillars poisoned with the lead hydrogen arsenate was somewhat greater. This fact may be partly due to the higher arsenic content of this compound. It is also possible that this substance, being more chemically reactive, is more rapidly absorbed into the tissues while the inert basic compound passes through the intestinal tract of the insect without the absorption of so much of the arsenic.

In conclusion, we acknowledge our indebtedness to Mr. R. H. Robinson who assisted in making the chemical analyses here reported and to Mr. G. F. Moznette who assisted in the Entomological work.

VICE-PRESIDENT COOLEY: Mr. George P. Gray will present the next paper.

SULFUR AS AN INSECTICIDE

By GEORGE P. GRAY

(Withdrawn for publication elsewhere.)

A large number of photographs illustrating the work of the Mediterranean fruit fly were exhibited by Mr. E. A. Back.

Session adjourned, 12 m.

Afternoon Session, August 10, 1915

The session was called to order at 2.15 p. m. by Mr. H. F. Wilson, president of the Pacific Slope Association of Economic Entomologists.

PRESIDENT WILSON: We will now listen to a paper prepared by Mr. C. P. Clausen which will be read by Mr. S. W. Foster.

A COMPARATIVE STUDY OF A SERIES OF APHID-FEEDING COCCINELLIDÆ[1]

By C. P. CLAUSEN, *University of California Citrus Experiment Station, Riverside, California.*[1]

Among the beneficial insects of California as well as elsewhere, the Coccinellidæ hold high rank as aphid and scale feeders. In order to determine the relative efficiency of some of the more important forms, a study of eight of the principal aphid-feeding species of this state was made at Sacramento during the season of 1913, and completed at Berkeley and Riverside in 1914. The species under observation were: *Hippodamia convergens* Guer., *Hippodamia ambigua* Lec., *Coccinella californica* Mann., *Coccinella trifasciata* Linn., *Olla oculata* Fabr., *Olla abdominalis* Say., *Cycloneda sanguinea* Linn., and *Adalia bipunctata* Linn.

At the time the investigations were undertaken, an extensive series of tests were made to determine the most satisfactory type of breeding cage for use in the laboratory. By far the most satisfactory results were secured by confining the individuals under observation in plain three-inch vials with cotton stoppers. The stoppers were covered

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[1] Paper No. 19. Citrus Experiment Station, College of Agriculture, University of California, Riverside, Cal.

with tissue paper to prevent the larvæ from becoming enmeshed in the cottony fibers. Approximately outdoor conditions as regards temperature and humidity were thus secured. Potted plants infested with aphids and covered with chimney glasses were tried for a time, but did not fulfill the requirements, due to the occasional condensation of moisture upon the glass surface and the tendency of the adult beetles to ascend to the top of the glass and to remain there inactive rather than feeding normally upon the infested plant.

The points taken up in the investigation were the following: The length of time intervening between emergence and mating and oviposition, the length of the oviposition period, the rate of oviposition, both as to the number of eggs per day and the total number for the entire period, the life histories, and the feeding habits, both in the larval and adult stages. In every case a sufficient number of individuals were started for each species to make it practically certain that at least ten would complete the test, making allowance for unavoidable mortality. The records given for each species, therefore, represent the average for approximately that number of individuals.

Emergence to Mating and Oviposition

No great divergence was found to exist between species as regards the length of time intervening between emergence and mating. The range extended from 1.6 days in the case of *A. bipunctata* to 2.7 days for *C. californica*. No records were secured of *H. convergens* due to the fact that all individuals used in the tests were taken from cold storage in the adult stage. From mating to oviposition the variation was from 8.6 days for *O. abdominalis* to 11.9 days for *C. californica*. The minimum period of time for a single individual was 7.0 days in the case of one female of *O. abdominalis* and one of *C. sanguinea*.

The Period of Oviposition

The period of time over which oviposition extends is very largely dependent upon the conditions under which the beetles are kept. Under optimum conditions the deposition of eggs takes place daily during a period extending from approximately two weeks after emergence until death. The maximum average was found to be 48.1 days for *H. ambigua* and the minimum 28.2 days for *A. bipunctata*. The comparatively low average for *H. convergens* may be accounted for by the fact that three of the eleven individuals under observation died within two weeks of the beginning of the experiment. Oviposition by one female of *H. ambigua* extended over a period of fifty-nine days.

Oviposition Records

Species	No. of Specimens	Length of Period, Days	Per cent Days Eggs Deposited	Average for Period	Average eggs Per Day
C. californica Mann.	10	31.0	69.5	207	8.0
C. trifasciata Linn.	10	29.2	75.0	249	8.4
H. convergens Guer.	11	33.3	63.8	299	8.9
H. ambigua Lec.	8	48.1	61.4	312	7.3
O. abdominalis Say.	9	34.7	70.3	234	6.3
O. oculata Fabr.	9	35.4	89.3	347	9.8
A. bipunctata Linn.	10	28.2	69.4	190	6.7
C. sanguinea Linn.	10	28.8	73.6	201	7.0

Rate of Oviposition

A very considerable difference was found to exist in the number of eggs deposited by the various species. As would be expected from field observations, *H. convergens* deposited the greatest number of eggs, 609 being secured from a single female, while the average for all individuals was 299, but leaving out of account the three females which died prematurely, the average for the species was 358 eggs. *O. oculata* was a very close second with 347, while *A. bipunctata* was least with a production of 190 eggs. The maximum number of eggs deposited by a single female in one day was 43 in the case of *H. convergens*, while *O. oculata* was last with a maximum of 22 eggs. The latter species, however, ranked first with respect to the daily average for the entire period with 9.8, while *O. abdominalis* was last with 6.3 eggs per day.

Frequency of Oviposition

The proportion of days upon which eggs were deposited varies greatly, the range being from 61.4 per cent for *H. ambigua* to 89.3 per cent for *O. oculata*. The latter species was found to be markedly uniform in this respect, the range among the nine individuals of the species being from 84.3 to 95.5 per cent, the minimum in this case being higher than the maximum of any other species. It will be noticed, however, that the regularity of oviposition was not in direct proportion to the total production of eggs, inasmuch as *H. ambigua*, the lowest with respect to the frequency of oviposition, ranked second in total production.

Life-History

A greater or less uniformity exists among the various species as regards the length of the different periods or stages of the life cycle. The egg stage ranged in length from 4.2 days for *O. abdominalis* to 6.0

days for *C. trifasciata*. In no case were more than six days required for incubation. Almost invariably the eggs comprising a cluster all hatched within a few hours. The first larval stage varied from 3.3 days for *O. abdominalis* to 5.7 days in the case of *C. californica*. A single larva of *C. californica* required ten days, but apparently was not normal and died shortly after pupation. The second larval stage was found to be uniformly shorter than the first, the variation being from 2.3 days for *O. abdominalis* to 4.7 days for *H. ambigua*. Nine larvæ of *H. ambigua*, three of *C. californica*, and one of *H. convergens* required only two days for this stage, while one specimen each of *H. ambigua* and *O. oculata* required six days. The third stage was of approximately the same length as the second, with the exception of *H. convergens*, in which case the period was much shorter. Two individuals of *O. oculata* required five days. The fourth stage was considerably longer than those preceding it, the range being from 4.7 days in the case of *O. abdominalis* to 7.4 days for *C. trifasciata*. The greatest variation, however, was found in the pupal stage, where 3.5 days were required by *O. abdominalis* and 8.0 for *H. ambigua*. The totals of the successive stages gave a minimum of 21.0 days for *O. abdominalis* and a maximum of 33.2 days for *H. ambigua*.

Duration of Different Stage in Days

Species	No. of Specimens	Egg Stage	Larval Stages.				Pupal Stage	Total
			First	Second	Third	Fourth		
C. californica Mann	13	5.4	5.7	3.3	3.4	6.8	4.5	29.1
C. trifasciata Linn	12	6.0	5.3	4.2	3.3	7.4	3.7	31.8
H. convergens Guer	8	5.0	3.9	3.6	2.3	6.5	7.5	28.8
H. ambigua Lec	10	5.5	3.8	4.7	3.6	7.3	8.0	33.2
O. abdominalis Say	14	4.2	3.3	2.3	2.8	4.7	3.5	21.0
O. oculata Fabr	11	5.0	4.6	4.5	4.2	7.0	5.1	30.2
A. bipunctata Linn	7	5.0	4.6	2.9	3.0	5.6	6.0	26.7
C. sanguinea Linn	10	5.3	4.5	3.7	3.2	4.9	4.2	25.3

Feeding Records

The average number of aphids eaten by a larva during the entire period ranged from 216 for *C. sanguinea* to 475 in the case of *C. californica*. One individual of the former species came to maturity after consuming 147 aphids, while one larva of *C. californica* required 580, this being the maximum for a single individual.

Daily feeding records of the adult beetles covering a fifteen-day period were secured with the exception of *H. convergens*, the records of which extend over only eight days. The maximum period average

was 624 aphids for *O. oculata*, and 234 as a minimum for *C. sanguinea*. One adult of the former species devoured 672 aphids during this period. On a daily basis the variation extended from 56.1 aphids per individual for *H. convergens* to 15.6 for *C. sanguinea*. *C. californica* was conspicuously low in this respect when the size of the beetle is considered, the average being only 34.0 aphids per day.

FEEDING RECORDS

Species	Larvæ				Adults		
	No. of Specimens	Length of Stage	Aphids Eaten		No. of Specimens	Length of Period	Aphids Eaten per Day
			Period	Daily			
C. californica Mann.	13	23.7 da.	475	24.9	10	15 da.	34.0
C. trifasciata Linn.	13	25.8	294	15.8	10	15	28.9
H. convergens Guer.	12	23.8	349	20.7	6	8	56.1
H. ambigua Lec.	8	27.7	312	11.4	10	15	26.5
O. abdominalis Say	14	16.7	240	19.8	9	15	30.4
O. oculata Fabr.	10	25.2	326	17.2	10	15	41.6
A. bipunctata Linn.	10	21.7	252	14.1	10	15	16.7
C. sanguinea Linn.	10	20.0	216	14.5	10	15	15.6

On the basis of the results secured in the studies previously outlined, the following conclusions may be drawn:

1. Temperature and humidity are very strong controlling factors in the development and behavior of the different species.
2. The number of eggs deposited under normal field conditions varies from 200 to 500 and occasionally more, extending over a period of four to eight weeks in case the female lives the full adult life.
3. The period intervening between emergence and mating is one to three days, and from mating to oviposition eight to eleven days. A period of ten to fifteen days thus intervenes between emergence and the beginning of oviposition.
4. Oviposition normally takes place daily, with occasional exceptions.
5. The number of aphids eaten by the larvæ of the different species varies approximately with the size of the individuals, the number varying from 216 to 475 for the entire larval period.
6. The above to a somewhat lesser extent is true of the adults also.

PRESIDENT WILSON: The next paper is by Mr. J. F. Illingworth and will be read by Mr. O. H. Swezey.

NOTES ON THE HABITS AND CONTROL OF THE CHICKEN FLEA

(*Echidnophaga gallinacea* Westwood)

By J. F. Illingworth, Ph.D., *Professor of Entomology, College of Hawaii, Honolulu, T. H.*

In this paper the writer desires to briefly summarize data which is to appear later in a bulletin from the College. His investigation of the life-history of the chicken flea shows that there is a great similarity in the development with that of ordinary fleas; and, that it is only in their adult stage where they become markedly specialized. Reviewing the literature we find numerous short references to this species, but none that would indicate a thorough knowledge of the life-cycle and means of control.

The species has appeared under several generic names since Westwood (1875)[1] placed it in the genus *Sarcopsyllus*. Enderlein (1903) created the genus *Argiopsylla* for it; and Baker, (1904) recognizing that it differed widely in structure from *Sarcopsylla penetrans*, gave it the new genus *Xestopsylla*. Finally, Jordan and Rothschild (1906) placed it in Olliff's (1886) old genus, *Echidnophaga*.

Hosts

Though, normally, fleas of this species infest poultry, the indication is that they attack any animal that comes in their way. The records mention dogs, cats, horses, rats, owls and man. They are particularly fond of young animals, and it has been noted that they are sometimes very annoying to children. In East Africa, 22.5 per cent of the fleas taken from rats were found to belong to this species; hence, these rodents are thought to be an important agent in their distribution. Recently, the writer discovered that they also infest the English sparrows, that flock into the chicken houses to the feed boxes.

Distribution

Though Westwood's description, in 1875, was from specimens found in India, the species is now pretty generally distributed around the world, favoring tropical and sub-tropical regions. A few of the places mentioned in the literature are: Africa, Italy, Russia, Asia, Fiji Islands, and America. This flea has been recorded in the southern United States since 1890; and one record extends the range as far north as Minnesota.

[1] See bibliography.

Life-History

In the study of the development of the fleas every effort was made to duplicate natural conditions. The fact that the adults of this species locate themselves rather permanently greatly simplified the problem of observing their habits of mating, egg-laying etc.

Newly emerged fleas, of both sexes, were placed in a large glass jar with a young rooster. The next morning ten females and eight males were found located upon the head of the bird. Short, gelatin capsules were then glued to the head, covering individual female fleas, so as to determine the number of eggs produced. During the day from one to two eggs were laid by each female, but on the following morning the capsules were full of eggs, and small pellets of blood—the excrement of the fleas. Careful observations were continued, renewing the capsules daily, as long as the fleas lived. It was a noticeable fact that egg-laying took place principally at night—often as many as forty eggs being produced by a single female at night and only one or two during the day.

Mating.—A careful, daily chart was kept of the location of the individual fleas on the rooster's head, and it was noted that the males shifted their positions during the night, but remained rather stationary during the day. The females remained practically in one location throughout their life—changing their position only when considerably disturbed, in some way.

Evidently, mating normally takes place at night, for rather constant daily observation failed to discover pairs in copula. On one occasion, some males that had emerged several days previously were placed on the bird, and after a short time they were observed copulating with the females which had been without males for several days. It is rather interesting to note, that in this species the male backs up to the female from below, extending and curving the end of his abdomen backward to secure the union, while he is practically standing on his head. The pairs observed remained attached only about five minutes.

Longevity Relative to Sex.—Of the fleas under observation on the fowl, the males quickly died off—living from two to six days after feeding and mating—while females lived from eighteen to forty days; producing eggs up to the time of their death.

In an experiment with fleas kept in jars without food or moisture after emerging, just the opposite was the case, the males greatly outliving the females—some of them remained alive and active for a full month.

Egg-Laying.—The fleas must evidently feed upon blood before they mate or are able to produce eggs. Several hundred newly

emerged fleas that were confined for many days in vials and jars without feeding, were not observed to mate and in no case were eggs produced.

Female fleas removed from fowls and placed in empty vials oviposit at once—from one to three eggs being produced. These fleas, if left in the vials, usually died during the following day.

Egg-production appears to depend largely upon the proximity of the males. The first and second day after mating the maximum number of eggs are produced; and, from that time on the number rapidly falls off until mating takes place again. Often females, that were not kept supplied with males, produced eggs which dried up quickly. By placing fresh males on the rooster's head from time to time, it was found that the females reproduced actively throughout their life.

THE EGGS.—The eggs are laid singly, and, being dry, they rolled about in the capsules, so that it was rather difficult to keep them from falling out. They are oval in form, about one third longer than wide, and a beautiful opalescent white.

Since the eggs are largely produced at night, they may be found abundantly on the roosting-board of infested fowls.

THE LARVÆ.—The incubation period was found to vary from three and one-half to four days, at ordinary summer temperature. Eggs kept under observation during hatching became yellowish; and by transmitted light the larva could be plainly distinguished within. By a jerking motion of the body, the hatching spine, which is located on the top of the head of the larva, was observed effectively making a single slit in the egg-shell; through which the larva escaped.

The newly-hatched larvæ are quite white and very active, wriggling about over the surface of the soil. Within a few hours, if kept under natural conditions, they turn dark, due to the food within the alimentary canal. As was mentioned above, the parent fleas are constantly producing pellets of dried blood, which fall with the eggs to the soil. The larvæ apparently feed upon this excrement exclusively.

The larvæ were found to molt three times—the hatching-spine disappeared at the first molt. The older larvæ burrow into the soil so that they were always found at the bottom of the jars in the experiments. When ready to pupate the food all leaves the alimentary canal and the larvæ become pearly-white again. The larval period was found to vary considerably—lasting from six to ten days at summer temperature.

THE PUPA.—When ready to pupate the larva spins a delicate cocoon, of the finest silk, which holds the particles of dust together around it. In most cases these cocoons were made against the glass, at the bottom of the breeding jars, so that the transformations could be observed through the wall.

After building the cocoon the larva remained doubled up inside for three to four days before pupating. The pupal stage lasts from six to nine days; the pupa beginning to turn dark several days before emerging. The entire life cycle, from egg to adult flea, was found to vary from twenty-two to twenty-nine days under ordinary summer conditions in Hawaii.

Control

Since the development in the early stages of this species follows so closely that of other fleas, standard methods of control were tried. The water treatment proved very successful. After washing out the roosting place each morning for a week, the fleas on the chickens became noticeably less; and after two weeks of such treatment they had practically disappeared.

Investigation shows that these fleas are most troublesome in dry localities and that wet districts, near the mountains are not troubled.

A Japanese, who has about two thousand fowls, located in the dry district, told the writer that he had no trouble with fleas, but that he did not know why he was free from them.

It was observed that he swept out the roosting places each morning; placed the droppings in water to macerate before applying them to his garden; and, that he used the sprinkling pot freely in the houses to keep down the dust. His treatment is one that recommends itself, not only for the general sanitation and health of the fowls, but also, it is a most satisfactory means of destroying the fleas.

Air-slacked lime has also proved very destructive to the developing fleas, and may often be used to advantage about the poultry house. A little of the dust-lime in the nests and other places, where it is better not to use water, keeps not only fleas but other pests from developing. In locations where water is scarce, the lime may be substituted, placing it under the roosts, etc.

Taxonomic Bibliography

1875. Westwood. Description of a New Pulicidous Insect from Ceylon. *Entomological Monthly Magazine*, Vol. II, p. 246.

1886. Olliff. Family Pulicidæ, Proc. Linn Soc. N. S. Wales, p. 172. Genus *Echidnophaga* created for the species *ambulans*, which was found infesting the Echidna.

1903. Enderlein. Argiopsylla N. G. for *Sarcopsylla gallinacea*. Valdivia Exp., iii, p. 263.

1904. Baker. Revision of American Siphonaptera. *Xestopsylla* N. G. for *Sarcopsylla gallinacea*. Proceedings of the United States National Museum p. 374, also p. 434.

1906. Jordan and Rothschild. Revision of the Sarcopsyllidæ. (University of Liverpool.)

PRESIDENT WILSON: The next paper will be presented by Mr. A. F. Burgess.

SOME PHASES OF GIPSY MOTH WORK IN NEW ENGLAND

By A. F. BURGESS, *Melrose Highlands, Mass*

(Withdrawn for publication elsewhere.)

PRESIDENT WILSON: We will now listen to a paper by Mr. E. D. Ball.

THE DISTRIBUTION OF THE BEET LEAF-HOPPER

By E. D. BALL, *Logan, Utah*

(Withdrawn for publication elsewhere.)

A general discussion followed this paper in regard to the leaf-hopper transmitting the disease concerned and it developed that definite facts concerning the transmission of the disease had been worked out under laboratory and field conditions by Prof. R. E. Smith and his associates in the University of California and would be published in a forthcoming number of *Phytopathology*.

PRESIDENT WILSON: The last paper on the program will be presented by Mr. G. N. Wolcott.

THE INFLUENCE OF RAINFALL AND THE NON-BURNING OF TRASH ON THE ABUNDANCE OF DIATRÆA SACCHARALIS[1]

By GEORGE N. WOLCOTT

(Abstract)

The most important insect injurious to sugar cane in the Western Hemisphere is the smaller moth stalk borer, *Diatræa saccharalis* Fabr., which occurs in abundance in the southern United States, Mexico, Cuba, Jamaica, Santo Domingo, Porto Rico, St. Kitts, Barbados, Trinidad, Demerara, and Argentina, besides other islands and countries of lesser importance in sugar production.

The larvæ of *Diatræa* cause the injury to the cane, as they bore into the stalks, eating the soft juicy pulp, opening the way for disease

[1] Published by permission of Mr. W. V. Tower, Director, Insular Experiment Station, Rio Piedras, Porto Rico.

organisms to enter, reducing the amount and purity of the juice, and weakening the strength of the stalk. The pupa is formed in the stalk, and the creamy-yellow, inconspicuously marked moths deposit eggs on the upper leaves of the cane.

The writer has visited most of the cane growing countries, and, being impressed by the notable variation in the amount of cane infested with the borer larvæ, has endeavored to determine the factors governing the abundance of the insect.

Working along similar lines in Louisiana, Mr. T. E. Holloway has contended (*Louisiana Planter*, December 19, 1914) that the abundance of *Diatræa* depends in large part upon the scarcity of the cosmopolitan and omnipresent egg parasite of the borer, *Trichogramma minutum*. Field experiments in Texas and Louisiana, carried on for two years by Mr. Holloway, have quite effectually demonstrated that the burning of the cane trash (tops and leaves) after the cane is harvested, destroys large numbers of *Trichogramma*, as is evidenced by a larger number of cane stalks injured by *Diatræa* in the succeeding crop than in check fields where the trash is not burned.

A large number of careful observations made in Porto Rico during the past grinding season, confirmed by the evidence from other countries, indicates that there is a constant relation between the amount of rainfall and the abundance of *Diatræa*. The accompanying table, which gives the percentages of infestation of cane by *Diatræa* in conjunction with the total annual rainfall in inches for 1914, shows that the abundance of *Diatræa* is in inverse proportion to the amount of rainfall. In the table, the abundance of *Diatræa* in fields where the trash was burned, and where the trash was *not* burned, is recorded separately, the difference amounting to nearly 100 per cent higher infestation by borer in fields where the trash has been burned.

That rainfall affects the abundance of the smaller moth borer is of scientific interest, but apparently no economic application can be made of this fact. But it is possible for planters to take advantage of the relation which has been found to exist between trash burning and borer infestation, and stop burning trash. In Cuba and northern Porto Rico, trash is seldom burned, and practically never in the British colonies. With a better understanding of the losses attendant upon burning the trash, it can usually be obviated elsewhere by the use of improved heavy-ratooning varieties and somewhat altered plantation practice.

It is comparatively easy to demonstrate the effect of an abundance of rainfall in lessening the numbers of *Diatræa*, but much more difficult to satisfactorily account for this effect. The eggs of the borer are deposited on the leaves of the cane, and when the young larvæ hatch, a considerable interval elapses while they crawl about on the cane

before they enter the stalk, or the midrib of the leaf. It is quite probable that this is one of the most crucial periods in its life history and that many newly hatched larvæ fail to enter the cane before they are washed off by the rain. It was observed in Cuba that considerable numbers of borer larvæ were killed in young cane by the more rapid growth of the central shoot of a cane plant than of the outer leaves. Also, larvæ were found which had been drowned in a mixture of water and decaying cane juices which had collected in their tunnels after rains. To avoid danger from these causes, many larvæ were found living outside the shoot, where they were exposed to the attacks of predators or parasites.

Summary

The abundance of the smaller moth borer, *Diatræa saccharalis*, the most important pest of sugar cane in the New World, depends upon two factors, rainfall and the burning of trash. Rainfall cannot be controlled, but in many cases in Porto Rico and elsewhere trash is needlessly burned. Burning trash increases the abundance of the borer 100 per cent. It is desirable that the burning of trash be avoided.

Total Annual Rainfall and Average Infestation of Sugar-Cane by Diatræa saccharalis at Various Localities in Porto Rico, also Infestation in Fields where the Trash Was Burned and where the Trash Was Not Burned.

Locality	Inches of Rainfall, 1914	Percentage of Infestation, 1914–15		
		Average of all Fields	Fields where Trash Was Burned	Fields where Trash Was *not* Burned
Coloso	101	6 (8)		6 (8)
Anasco	95	5 (6)		5 (6)
Fajardo	76[1]	11 (15)	13 (6)	9 (9)
Manati-Morovis	72	6 (9)	10 (2)	4 (7)
Canovanas	70	11 (4)		11 (4)
Toa Baja	70	15 (8)	19 (4)	10 (4)
Rio Piedras	66	17 (7)		17 (7)
Vega Baja	66	39 (9)	44 (5)	26 (4)
Caguas	58	6 (5)		6 (5)
Yabucoa	58	37 (5)	60 (2)	22 (3)
Arecibo	55	26 (16)	69 (1)	23 (15)
Juana Diaz	60	32 (9)	34 (8)	18 (1)
Guayama-Josepha	45	47 (4)	47 (4)	
Aguirre	34	45 (7)	50 (5)	31 (2)
Potala	27	37 (9)	44 (6)	24 (3)
Ponce	25	48 (8)	48 (8)	
Destino-Salinas	23	64 (5)	77 (3)	44 (2)
Guayanilla	24	76 (5)	76 (5)	
Sn. Isabel	22	72 (4)	78 (3)	46 (1)
Guanica	21	66 (28)	68 (24)	31 (4)

Note.—Figures in ( ) after percentages indicate numbers of fields examined.

[1] Average of rainfall of haciendas, not of the town.

Mr. O. H. SWEZEY: Trichogramma has a short life cycle and in case the trash could be left a short time the adults would emerge.

MR. G. N. WOLCOTT: In Porto Rico the cane and trash is burned immediately.

VICE-PRESIDENT COOLEY resumed the chair and called for the report of the committee on resolutions.

REPORT OF COMMITTEE ON RESOLUTIONS

Resolved, That the American Association of Economic Entomologists at its special summer meeting desires to voice its appreciation, first, to the authorities of the University of California, for courtesies extended; second, to the Pacific Slope Association of Economic Entomologists and to the individual entomologists for their coöperation; and, lastly, to Professor R. A. Cooley, for his able supervision at the sessions and for his timely address.

E. A. BACK,
F. C. BISHOPP,
A. L. MELANDER,
Committee.

By vote of the association the resolutions were adopted.

VICE-PRESIDENT COOLEY: We will now listen to the report of the committee appointed to confer with a similar committee from the Pacific Slope Association of Economic Entomologists.

REPORT OF SPECIAL COMMITTEE[1]

Your committee, appointed to confer with a like committee from the Pacific Slope Association of Economic Entomologists with reference to an affiliation, recommend that that Association be affiliated as a branch association to be known as the Pacific Slope Branch of the American Association of Economic Entomologists and that the membership requirements, dues and privileges of its members be the same as for other members of this Association.

It is further recommended that the following amendment to the constitution providing for this change be adopted.

That the words "Branch or" be inserted before the word "section" in line 2 of Section 1 of Article 3 of the Constitution.

Respectfully submitted,

C. P. GILLETTE,
A. F. BURGESS,
E. D. BALL,
E. O. ESSIG,
Committee.

After a general discussion it was voted that the report be accepted and that the recommendations be presented to the American Association of Economic Entomologists at the next annual meeting.

[1]As the members of the committee agreed on the matters under consideration, a joint report was submitted.

Before adjourning, the Secretary called attention to the fact that the meeting had been favored with the presence of three past presidents of the Association and that this had added much to the occasion, also that it was an especial pleasure that Prof. Lawrence Bruner, who had recently been honored by his state as its most distinguished citizen, was present on this occasion.

There being no further business the session adjourned at 5 p. m.

R. A. COOLEY, *Vice-President.* A. F. BURGESS, *Secretary.*

GRYLLOTALPA GRYLLOTALPA LINN., THE EUROPEAN MOLE CRICKET IN NEW JERSEY

By HARRY B. WEISS, *New Brunswick, N. J.*

During the early part of July, 1915, my attention was called to an underground insect which was cutting off the roots of various plants in a nursery at Rutherford, N. J. Upon making a search, a mole cricket considerably larger than our common but by no means abundant *Gryllotalpa borealis* Burm., was found to be responsible for the injury. Mr. J. A. G. Rehn, to whom a specimen was submitted, pronounced it *Gryllotalpa gryllotalpa* Linn., the European mole cricket. The infestation which is undoubtedly of several years' duration, extends over several acres planted to herbaceous and ornamental stock, a considerable portion of which is used for show purposes only. The soil is rather light and porous and contains a variety of shrubs, shade trees, evergreens, etc., such as one would naturally find in a nursery. No preference was shown by the cricket for any particular plant, its zig-zag burrows being found in different parts of the area irrespective of the kinds of plants growing there.

The insects were numerous enough for the nursery to detail several men to hunt them out and destroy as many as possible every few days and to sink empty flower pots in the ground, covering them with boards, for trapping purposes.

Malcolm Burr in his "Synopsis of the Orthoptera of Western Europe" records this species as occurring through Europe, and from Sweden to Spain, rare and local in England, abundant in France, often doing damage to gardens, common in Belgium. At Rutherford, where the insect was discovered, large amounts of imported stock are received every year. There were consigned to this locality during 1914, more than five thousand parcels of imported stock and during the spring of 1915, over two thousand parcels were received. The majority of this stock comes from Belgium and Holland and only a small

portion from France. Inasmuch as it is chiefly Holland and Belgian stock which comes over with soil around the roots and inasmuch as a porton of this is always planted temporarily in the now infested area, it is almost certain that the insect came from one or both of these countries.

E. Bourcart in "Insecticides, Fungicides and Weedkillers" gives a short account of this species in which he states that it lives almost entirely on insects and their larvæ, cutting all roots that hinder it in its search for this food. The winter is passed at various depths, depending upon the temperature and amount of moisture present. In the spring it ascends and excavates numerous runs within a few centimetres of the surface. Bourcart further states that it takes twelve years for the number of these insects to increase so far as to render culture impossible. The existence of each insect is three years, each female depositing two hundred eggs, but multiplication is comparatively slow.

Other European writers state that the food of the mole cricket consists largely of vegetable matter but all agree in that it is cannibalistic at times. According to Bastin, eggs are laid in a specially constructed chamber, the adult caring for them and feeding the young until their first moult, when the family disperses.

Coming to remedies, Bourcart mentions the use of poisoned pastes, of maize, starch, water and phosphorus, being placed in the burrows and the openings closed. In Italy, liming at the rate of 16 cwt. to the acre is supposed to remove the crickets. Petroleum or a 25 per cent emulsion of petroleum poured into the burrows has also been used in Europe. Ratzeburg, in 1847, advised the injection of oil into the tunnels and afterward sprinkling the surface with water. Bourcart also mentions the use of naphthaline in the ground as it is being tilled and also raking the soil until the surface is clean, then beating it and adding water if necessary. During the night the mole crickets dig new tunnels which are seen the next morning. These are opened with the fingers and tepid soapy water poured in.

Worsham and Reed, in Bull. 101 of the Georgia Experiment Station on *Scapteriscus didactylus* Latr., advocate for that species the ploughing of breeding areas to destroy the eggs by exposing them to the sun, etc., light traps at certain seasons, compost heap traps during the winter, poisoned baits made of cottonseed meal and arsenicals, sulphur and naphthaline as repellants and the banding of individual plants by means of tin, paper or wire cylinders.

The presence of the European mole cricket in New Jersey is simply an example of how impossible it is to keep out all foreign pests by a close inspection of foreign stock. No matter how careful the inspector is, something is bound to get by and cause trouble later on.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

OCTOBER, 1915

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photo-engraving, may be obtained by authors at cost. The receipt of all papers will be acknowledged.—EDS.

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The California meeting shows that the term American has a vital meaning in the name of the Association and the action of the Pacific Slope Association of Economic Entomologists indicates a willingness on the part of the members of that organization to make the adjective under discussion thoroughly characteristic. It is by all means better to have one strong association providing adequate representation and opportunity for the varied interests and it is hoped that the preliminary action of last summer may come to a successful fruition at the next annual meeting. Many problems are being studied under varying conditions found in different parts of the country and it is most desirable that the strongest association of practical entomologists should be comprehensively American in its membership, and recognize, as it does in its foreign members, the great value of the work done in other countries.

The report of the special summer meeting indicates an interesting and profitable gathering. It is regrettable that not more of the eastern men could attend and secure for themselves every benefit to be derived from national sessions held in regions presenting not only peculiar but important entomological problems. There is much for the eastern man to learn from his colleagues of the West. California has led the way with county entomologists. It was within her boundaries that the utility of hydrocyanic acid gas for the fumigation of fruit trees was demonstrated, that the lime, salt and sulphur wash (primarily a sheep dip) was first applied to fruit trees and there also occurred a most striking demonstration of how insects may be used to control insects and the necessity of one insect to the production of an important fruit. These bright pages of entomological history

were written under the stimulus of specialization compelled by climatic and other conditions. It is not too much to suppose that the excellent work of earlier years has been continued and in due time will result in additional contributions of both scientific and practical value. The pages may not all be as optimistic as those alluded to above, nevertheless they may contain much of great importance and contribute materially to the welfare of the nation. There are many specialities in the far West, controlled by men of keen intellect, and he who fails to keep an eye on his brother of the Pacific Slope should not complain if he falls behind in the race.

Obituary

JOSEPH TARRIGAN MONELL

JOSEPH TARRIGAN MONELL, prominent aphidologist and mining engineer, died at his home in St. Louis, Mo., May 9, 1915. He was born in St. Louis September 15, 1859, was educated at Smith's Academy and Washington University, from which latter institution he received the degree of mining engineer in 1881. Although his vocation was that of mining engineer, a profession which he practiced successfully, he was from the age of fourteen an ardent student of nature, more especially entomology and botany and was a volunteer student under Dr. C. V. Riley and under Dr. George Engelmann, the botanist. He was known among entomologists as an authority on the Aphididæ, in which group he published several articles, his first contribution being published at the age of seventeen. Although he published nothing after becoming actively engaged in engineering work, he continued his studies and was ever ready and willing to assist others. In his death entomology has sustained an irreparable loss. A widow and three children survive.

J. J. D.

Current Notes

Conducted by the Associate Editor

Instruction in beekeeping is soon to be given in the College of Agriculture of Cornell University.

Mr. A. H. Jennings, Bureau of Entomology, will be stationed in New York City, for some time, on mosquito work.

Dr. W. E. Britton, state entomologist of Connecticut, gave an illustrated lecture at the New York Botanical Garden, August 14, on "Fighting the Gipsy Moth."

Dr. A. A. Allen has been appointed assistant professor of ornithology in Cornell University and will give new courses in the economic phases of the subject.

Mr. Eric S. Cogan of British South Africa is employed as a temporary assistant, Bureau of Entomology, and has been assigned to the Charleston (Mo.) laboratory.

Mr. C. L. Scott of the Brownsville (Tex.) laboratory, Bureau of Entomology, is investigating the spread of the fall army worm (*Laphygma frugiperda*) in Texas and Louisiana.

Prof. F. L. Washburn, state entomologist of Minnesota, gave an address on "Problems in Nursery Inspection," before the American Association of Nurserymen at Detroit, June 23–25.

Dr. W. D. Hunter visited Boston, Albany, and other points in the northeast, in connection with the work of the Horticultural Board, during the early part of July.

Dr. Carlos J. Finley of Cuba, who thirty-four years ago claimed that mosquitoes were responsible for the transmission of yellow fever, died August 20, at eighty-two years of age.

Dr. W. C. Gorgas, surgeon general, United States Army, was scheduled as one of the speakers before the American Public Health Association at Rochester, N. Y., September 7.

According to *Science*, Dr. David Starr Jordan has recently been elected a member of the Royal Swedish Academy of Sciences at Stockholm, in appreciation of his work in zoölogy.

The Dominion of Canada has appropriated $20,000 for entomology, and $100,000 for the administration and enforcement of the destructive insect and pest act for the fiscal year of 1915–16.

Dr. T. J. Headlee, state entomologist of New Jersey, and Mr. B. H. Walden, assistant entomologist of Connecticut, were speakers at an anti-mosquito meeting at Sachem's Head, Guilford, Conn., August 14.

At a recent meeting of the directors of the Florida Citrus Exchange resolutions were adopted heartily indorsing the work against citrous pests, conducted by Mr. W. W. Yothers of the Bureau of Entomology.

Mr. Reuben Cox of the Mississippi Agricultural College has been appointed a temporary field assistant of the Bureau of Entomology and will work with Mr. D. L. Van Dine on the investigation of malaria mosquitoes.

About thirty members of the Baltimore Beekeepers' Club visited the apiary and laboratory of the Bureau of Entomology at Drummond, Md., on Saturday afternoon, July 24. Various demonstrations were arranged for them in the apiary.

According to *Science*, Mr. Charles P. Lounsbury, chief entomologist of the South African Union, who has been visiting Australia, was expected to reach San Francisco about September 1, and to spend several months in the United States.

Dr. A. L. Quaintance, Bureau of Entomology, recently visited field laboratories at Winchester, Va., North East, Pa., and Benton Harbor, Mich., for the purpose of conferring with men in charge of stations regarding work under way and contemplated.

Mr. V. G. Stevens of Leland Stanford Junior University, Cal., has been appointed as a field assistant in the Bureau of Entomology for the purpose of assisting Mr. W. M. Davidson at Walnut Creek, Cal., in investigations of the grape Phylloxera.

Mr. F. C. Craighead, Bureau of Entomology, recently spent about a week in Tyrone, Pa., in the study of insects affecting a plantation of poplar trees and the making of general observations on insects affecting forest and shade trees.

It has been announced in *Science* that the medal and grant for 1915 of the South African Association for the advancement of Science have been awarded to Mr. C. P. Lounsbury, chief of the Division of Entomology, Union Department of Agriculture.

Mr. W. D. Pierce, Bureau of Entomology, spent the latter half of July in determining the status of the boll weevil in the region first invaded during the fall of 1914, and in visiting the laboratories at Clarksville, New Orleans, Thomasville, and Batesburg.

Mr. G. N. Wolcott of the Porto Rico Board of Agriculture was in Washington on July 27. He will attend the meetings at San Francisco and in the fall will spend some little time as a collaborator at the laboratory investigating sugar-cane insects at New Orleans.

In the August issue of this JOURNAL occurs a note copied from *Science* regarding the death of Joseph Farrigan. The name is an error and the note refers to the death of Joseph Tarrigan Monell. More information is given in the obituary notice on another page of this issue.

Mr. Dwight Isely, Bureau of Entomology, working on grape insects at North East, Pa., is visiting the Benton Harbor (Mich.) laboratory for the purpose of making observations on the grape-berry moth in that region. Upon completion of his investigation he will return to his headquarters at North East, Pa.

The American Medicine Gold Medal has been awarded to Surgeon General Rupert Blue of the Public Health Service, as the American physician who has done most for humanity in the domain of medicine during 1914. Dr. Blue was placed in charge of eradicating the bubonic plague from San Francisco in 1907.

The squash lady bird (*Epilachna borealis* Fab.) was reported as being very injurious during the last week of July to squashes in and near tidewater Virginia, where it has also been rated a pest of great importance in certain years. It will be interesting to know if this species causes such injury elsewhere.

According to *Science*, Edgar M. Ledyard, formerly assistant professor of entomology in the University of the Philippines, who has spent the last year in research work in the laboratory of parasitology of the University of California, has been appointed director of the Agricultural Department of the United States Smelting Company, Salt Lake City, Utah.

A circuit of beekeepers' meetings is to be held in the Middle West in December, ten associations meeting in succession. The object of this plan is to enable speakers and exhibitors to attend with the minimum expense and time. Meetings will be held in Ohio, Indiana, Illinois (2), Missouri, Kansas, Iowa, Minnesota, Wisconsin, and Michigan.

An outbreak of unusual severity of the onion thrips was reported to the Bureau of Entomology in Marshall County, Indiana, and vicinity, during July. The localities from which these reports emanated included Donaldson, Grovetown, Hamlet, Walkerton, and Plymouth, and our correspondents stated that the thrips seriously threatened the onion crop over a very considerable acreage.

Dr. A. H. McCray, Bureau of Entomology, is now stationed at the Drummond laboratory. He is continuing the work of examining samples of diseased brood sent in for determination, and is also taking up some new lines of investigation of bee diseases. Dr. McCray received the degree of doctor of medicine from George Washington University in June.

Prof. Wilmon Newell has resigned his position as state entomologist of Texas and professor of entomology at the Texas A. & M. College, to accept the position of state plant commissioner of Florida. As commissioner he will have charge of the work of citrus canker eradication and general supervision of the state work in entomology, plant pathology and nursery inspection, with headquarters at Gainesville.

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Dr. A. A. Allen has been appointed assistant professor of ornithology in Cornell University and will give new courses in the economic phases of the subject.

Mr. Eric S. Cogan of British South Africa is employed as a temporary assistant, Bureau of Entomology, and has been assigned to the Charleston (Mo.) laboratory.

Mr. C. L. Scott of the Brownsville (Tex.) laboratory, Bureau of Entomology, is investigating the spread of the fall army worm (*Laphygma frugiperda*) in Texas and Louisiana.

Prof. F. L. Washburn, state entomologist of Minnesota, gave an address on "Problems in Nursery Inspection," before the American Association of Nurserymen at Detroit, June 23–25.

Dr. W. D. Hunter visited Boston, Albany, and other points in the northeast, in connection with the work of the Horticultural Board, during the early part of July.

Dr. Carlos J. Finley of Cuba, who thirty-four years ago claimed that mosquitoes were responsible for the transmission of yellow fever, died August 20, at eighty-two years of age.

Dr. W. C. Gorgas, surgeon general, United States Army, was scheduled as one of the speakers before the American Public Health Association at Rochester, N. Y., September 7.

According to *Science*, Dr. David Starr Jordan has recently been elected a member of the Royal Swedish Academy of Sciences at Stockholm, in appreciation of his work in zoölogy.

The Dominion of Canada has appropriated $20,000 for entomology, and $100,000 for the administration and enforcement of the destructive insect and pest act for the fiscal year of 1915–16.

Dr. T. J. Headlee, state entomologist of New Jersey, and Mr. B. H. Walden, assistant entomologist of Connecticut, were speakers at an anti-mosquito meeting at Sachem's Head, Guilford, Conn., August 14.

At a recent meeting of the directors of the Florida Citrus Exchange resolutions were adopted heartily indorsing the work against citrous pests, conducted by Mr. W. W. Yothers of the Bureau of Entomology.

Mr. Reuben Cox of the Mississippi Agricultural College has been appointed a temporary field assistant of the Bureau of Entomology and will work with Mr. D. L. Van Dine on the investigation of malaria mosquitoes.

About thirty members of the Baltimore Beekeepers' Club visited the apiary and laboratory of the Bureau of Entomology at Drummond, Md., on Saturday afternoon, July 24. Various demonstrations were arranged for them in the apiary.

According to *Science*, Mr. Charles P. Lounsbury, chief entomologist of the South African Union, who has been visiting Australia, was expected to reach San Francisco about September 1, and to spend several months in the United States.

Dr. A. L. Quaintance, Bureau of Entomology, recently visited field laboratories at Winchester, Va., North East, Pa., and Benton Harbor, Mich., for the purpose of conferring with men in charge of stations regarding work under way and contemplated.

Mr. V. G. Stevens of Leland Stanford Junior University, Cal., has been appointed as a field assistant in the Bureau of Entomology for the purpose of assisting Mr. W. M. Davidson at Walnut Creek, Cal., in investigations of the grape Phylloxera.

Mr. F. C. Craighead, Bureau of Entomology, recently spent about a week in Tyrone, Pa., in the study of insects affecting a plantation of poplar trees and the making of general observations on insects affecting forest and shade trees.

It has been announced in *Science* that the medal and grant for 1915 of the South African Association for the advancement of Science have been awarded to Mr. C. P. Lounsbury, chief of the Division of Entomology, Union Department of Agriculture.

Mr. W. D. Pierce, Bureau of Entomology, spent the latter half of July in determining the status of the boll weevil in the region first invaded during the fall of 1914, and in visiting the laboratories at Clarksville, New Orleans, Thomasville, and Batesburg.

Mr. G. N. Wolcott of the Porto Rico Board of Agriculture was in Washington on July 27. He will attend the meetings at San Francisco and in the fall will spend some little time as a collaborator at the laboratory investigating sugar-cane insects at New Orleans.

In the August issue of this JOURNAL occurs a note copied from *Science* regarding the death of Joseph Farrigan. The name is an error and the note refers to the death of Joseph Tarrigan Monell. More information is given in the obituary notice on another page of this issue.

Mr. Dwight Isely, Bureau of Entomology, working on grape insects at North East, Pa., is visiting the Benton Harbor (Mich.) laboratory for the purpose of making observations on the grape-berry moth in that region. Upon completion of his investigation he will return to his headquarters at North East, Pa.

The American Medicine Gold Medal has been awarded to Surgeon General Rupert Blue of the Public Health Service, as the American physician who has done most for humanity in the domain of medicine during 1914. Dr. Blue was placed in charge of eradicating the bubonic plague from San Francisco in 1907.

The squash lady bird (*Epilachna borealis* Fab.) was reported as being very injurious during the last week of July to squashes in and near tidewater Virginia, where it has also been rated a pest of great importance in certain years. It will be interesting to know if this species causes such injury elsewhere.

According to *Science*, Edgar M. Ledyard, formerly assistant professor of entomology in the University of the Philippines, who has spent the last year in research work in the laboratory of parasitology of the University of California, has been appointed director of the Agricultural Department of the United States Smelting Company, Salt Lake City, Utah.

A circuit of beekeepers' meetings is to be held in the Middle West in December, ten associations meeting in succession. The object of this plan is to enable speakers and exhibitors to attend with the minimum expense and time. Meetings will be held in Ohio, Indiana, Illinois (2), Missouri, Kansas, Iowa, Minnesota, Wisconsin, and Michigan.

An outbreak of unusual severity of the onion thrips was reported to the Bureau of Entomology in Marshall County, Indiana, and vicinity, during July. The localities from which these reports emanated included Donaldson, Grovetown, Hamlet, Walkerton, and Plymouth, and our correspondents stated that the thrips seriously threatened the onion crop over a very considerable acreage.

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while it is fresh and succulent. The ears of the injured corn have the appearance of having had the silk cut off as by a knife, the feeding is so even and smooth. The beetle caused serious losses on many farms.

As the Luperodes beetles congregated only on the silk at the ends of the ears, and as the plants were in most cases at least eight to ten feet high with the ears five or six feet from the ground, difficulty was at first encountered in properly applying arsenical poisons. D. L. Williams of Rankin County, Mississippi, deserves credit for devising a very satisfactory method of applying the arsenicals for these beetles. He filled an ordinary "talcum powder" can with Paris green and while walking between the rows of corn stopped at each plant just long enough to shake the poison directly upon the silk. In this way none of the Paris green was wasted and it fell just where it was needed. The corn was treated rapidly as one man covered a number of acres each day. Mr. Williams stated that the men applying the Paris green walked at a slow steady gait. It required just one shake of the "talcum powder" can at each plant. In the fields that were treated in this manner, relief from these beetles was immediately obtained. Untreated fields were much more seriously damaged, as the beetles remained on the plants and continued to eat the silk as fast as it grew out from the ears.

All of the records we have of this species show that the beetles appear in injurious numbers about July 1 in the Gulf States. Some years no complaints are received and it is frequently a minor pest of cotton, devouring both the leaves and blossoms. In 1905 in his Monograph of Insect Injurious to Indian Corn, Professor S. A. Forbes wrote in regard to this beetle that "Its life-history is unknown." If anyone has learned anything in regard to the life-history of this species, it should be published.

R. W. Harned, *Agricultural College, Miss.*

TWENTY-EIGHTH ANNUAL MEETING AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

The twenty-eighth annual meeting of the American Association of Economic Entomologists will be held at Columbus, O., during the Christmas holidays. Members will be duly notified of further details concerning the meeting and of arrangements for hotel headquarters and railroad rates.

At the annual meeting action will be taken on applications for membership in the Association and blank forms for making application for membership can be secured from the Secretary or from Prof. Wilmon Newell, Gainesville, Fla., who is Chairman of the Committee on Membership. It is particularly requested that parties desiring membership should file their applications, properly made out, as early as possible so as to facilitate the work of the Committee on Membership at the time of the meeting.

A. F. Burgess, *Secretary.*

Mailed October 15, 1915.